



**Short Range Devices (SRD) operating
in the frequency range 25 MHz to 1 000 MHz with power levels
ranging up to 500 mW e.r.p.;**
**Part 2: Harmonised Standard for access to radio spectrum
for non specific radio equipment**

ReferenceREN/ERM-TG28-566

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ETSI650 Route des Lucioles
F-06921 Sophia Antipolis Cedex - FRANCE

Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - APE 7112B
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Foreword

This draft Harmonised European Standard (EN) has been produced by ETSI Technical Committee Electromagnetic compatibility and Radio spectrum Matters (ERM), and is now submitted for the Enquiry and Vote phase of the ETSI Standardisation Request deliverable Approval Procedure.

The present document has been prepared under the Commission's standardisation request C(2015) 5376 final [i.5] to provide one voluntary means of conforming to the essential requirements of Directive 2014/53/EU on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC [i.2].

Once the present document is cited in the Official Journal of the European Union under that Directive, compliance with the normative clauses of the present document given in table A.1 confers, within the limits of the scope of the present document, a presumption of conformity with the corresponding essential requirements of that Directive and associated EFTA regulations.

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Introduction

The present document is part 2 of a multi-part deliverable covering Short Range Devices (SRD) operating in the frequency range 25 MHz to 1 000 MHz.

Compared to earlier versions, a clarification has been made regarding the maximum occupied bandwidth requirement which is now split into two different requirements: occupied bandwidth and transmitter frequency stability in order to clearly separate the impact of Tx frequency drift on the transmitted signal, from the spectrum broadening due to modulation. Out of band transmission masks have also been split into two different requirements, one spectrum mask applying to the operating channel and a separate spectrum mask applying to the permitted frequency band. Adjacent channel power limits have been reviewed as a discrepancy in values was corrected. New receiver requirements have been added according to the ETSI EG 203 336 [i.4], on Rx parameters. Some of these parameters were previously only applicable to specific life critical application with extremely high receiver performances also called Receiver Category 1. Although the requirements are now applied generally, the limits have been adapted to non specific SRD category.

Special attention is drawn to new clauses 4.1 and 5.1 which ensure that requirements and tests apply at all operating conditions within the environmental profile given by the equipment's intended use. The intended use is provided in equipment documentation according to article 10 of the Radio Equipment Directive 2014/53/EU [i.2].

The present document is structured as follows:

- Clause 2 provides references.
- Clause 3 provides definitions of terms, symbols and abbreviations used.
- Clause 4 provides operating conditions and technical requirements specification.
- Clause 5 provides testing for compliance with technical requirements.
- Annex A (informative) provides the relationship between the present document and the essential requirements of Directive 2014/53/EU [i.2].
- Annex B (normative): EU wide harmonised national radio interfaces from 25 MHz to 1 000 MHz.
- Annex C (normative): National Radio Interfaces not EU wide harmonised.
- Annex D (normative): Test sites and arrangements for radiated measurement
- Annex E (normative): Test fixture
- Annex F (informative): Guideline for operating channel
- Annex G (informative): Properties of EUT.
- Annex H (informative): Maximum measurement uncertainty
- Annex I (informative): Selection of technical parameters.
- Annex J (informative): Bibliography.
- Annex K (informative): Change history.

1 Scope

The present document specifies technical characteristics and methods of measurements for Short Range Devices in the non-specific category operating in the frequency range 25 MHz to 1 000 MHz.

The non specific SRD category is defined by the EU Commission Decision 2019/1345/EU [i.3] as:

"The non-specific short-range device category covers all kinds of radio devices, regardless of the application or the purpose, which fulfil the technical conditions as specified for a given frequency band. Typical uses include telemetry, telecommand, alarms, data transmissions in general and other applications".

These radio equipment types are capable of transmitting up to 500 mW effective radiated power and operating indoor or outdoor.

NOTE: The relationship between the present document and the essential requirements of article 3.2 of Directive 2014/53/EU [i.2] is given in annex A.

2 References

2.1 Normative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

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NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

No reference document is necessary for the application of the present document.

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

- [i.1] [CEPT/ERC/REC 70-03](#): "Relating to the use of Short Range Devices (SRD)". June 2023.
- [i.2] [Directive 2014/53/EU](#) of the European Parliament and of the Council of 16 April 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC.
- [i.3] [Commission Implementing Decision \(EU\) 2019/1345](#) of 2 August 2019 amending Decision 2006/771/EC updating harmonised technical conditions in the area of radio spectrum use for short-range devices.
- [i.4] ETSI EG 203 336 (V1.2.1): "Guide for the selection of technical parameters for the production of Harmonised Standards covering article 3.1(b) and article 3.2 of Directive 2014/53/EU".

- [i.5] [Commission Implementing Decision C\(2015\) 5376 final of 4.8.2015](#) on a standardisation request to the European Committee for Electrotechnical Standardisation and to the European Telecommunications Standards Institute as regards radio equipment in support of Directive 2014/53/EU of the European Parliament and of the Council.
- [i.6] [ECC Report 200](#): "Co-existence studies for proposed SRD and RFID applications in the frequency band 870-876 MHz and 915-921 MHz", September 2013.
- [i.7] Recommendation ITU-T O.153 (10/92): "Basic parameters for the measurement of error performance at bit rates below the primary rate".
- [i.8] CISPR 16 (2019) part 1-1: "Specification for radio disturbance and immunity measuring apparatus and methods; Part 1: Radio disturbance and immunity measuring apparatus".
- [i.9] ETSI TR 100 028 (all parts) (V1.4.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics".
- [i.10] ETSI TR 102 273-2 (V1.2.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Improvement on Radiated Methods of Measurement (using test site) and evaluation of the corresponding measurement uncertainties; Part 2: Anechoic chamber".
- [i.11] ETSI TR 102 273-3 (V1.2.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Improvement on Radiated Methods of Measurement (using test site) and evaluation of the corresponding measurement uncertainties; Part 3: Anechoic chamber with a ground plane".
- [i.12] ETSI TR 102 273-4 (V1.2.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Improvement on Radiated Methods of Measurement (using test site) and evaluation of the corresponding measurement uncertainties; Part 4: Open area test site".
- [i.13] [CEPT/ERC/REC 74.01](#): "Unwanted emissions in the spurious domain", May 2019.

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the terms given in Radio Equipment Directive [i.2], and the following apply:

ACKnowledgement (ACK): brief communication (burst) from a message responder to a message initiator confirming successful reception of the message

Adaptive Frequency Agility (AFA): capability of an equipment to dynamically change the operating channel within its available frequencies for proper operation. For the purpose of the present document, non-overlapping channels are assumed

NOTE: Dynamic change of a channel can be triggered by sensing an occupied channel (e.g. CCA), etc.

adjacent channel: frequency range equal to the width of the operating channel immediately above or immediately below the operating channel

NOTE: See Figure 1.

adjacent channel selectivity: measure of the capability of the receiver to receive a wanted signal without exceeding a given degradation due to the presence of an unwanted signal which differs in frequency from the wanted signal by an amount equal to the OCW

alternate channel: frequency range equal to the width of the operating channel spaced twice the OCW away

NOTE: See Figure 1.

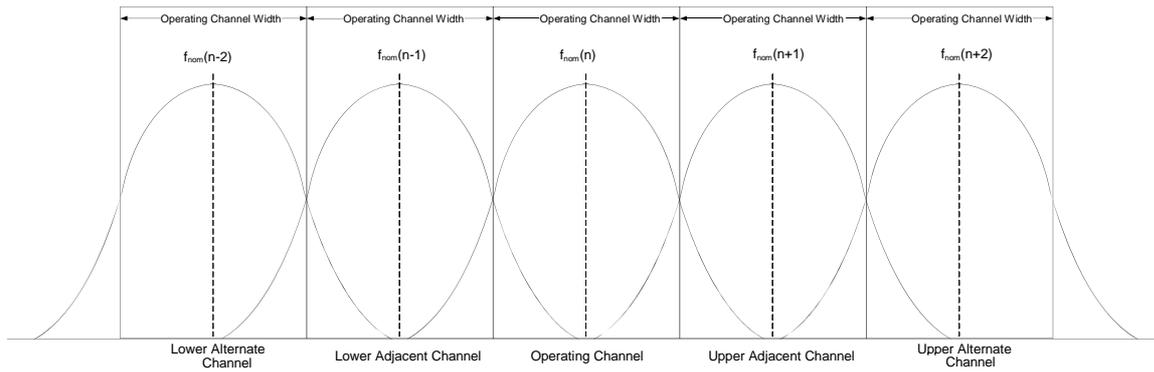


Figure 1: Adjacent and alternate channels definitions

blocking: measure of the capability of a receiver to receive a wanted signal without exceeding a given degradation due to the presence of an unwanted input signal at any frequency other than those of the spurious responses frequencies or of the adjacent channels

channel spacing: separation, in Hertz, between adjacent nominal operating frequencies

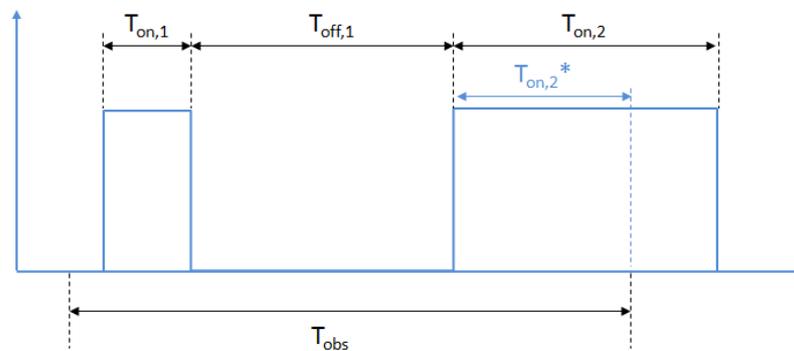
Clear Channel Assessment(CCA): procedure of sensing the operating channel to determine whether or not it is occupied by a transmission

conducted measurements: measurements which are made using a direct 50 Ω connection to the equipment under test

continuous transmission: transmission without interruption for the period of the test

cumulative on time (T_{on_cum}): sum of T_{on} , within T_{obs}

NOTE: See Figure 2.



In this example: $T_{on_cum} = T_{on,1} + T_{on,2}^*$

Figure 2: Illustration for Cumulative On-Time

dedicated antenna: removable antenna supplied and tested with the radio equipment, designed as an indispensable part of the equipment

deferral time: random time a transmission is deferred before a retry to CCA when a channel was not free

disregard time ($T_{disregard}$): time interval between two separate radio emissions in an operating channel below which they are considered a single continuous transmitted burst. For FHSS equipment, $T_{disregard}$ applies between emissions in different hopping channels

NOTE 1: See Figure 4.

NOTE 2: The value used for $T_{disregard}$ is a property of the EUT (see Annex G).

Duty Cycle (DC): ratio expressed as a percentage, of the cumulative duration of transmissions T_{on_cum} within an observation interval T_{obs} . $DC = \left(\frac{T_{on_cum}}{T_{obs}} \right)_{F_{obs}}$ on an observation bandwidth F_{obs}

Duty Cycle Template (DCT): duty cycle respecting limits with additional constraints of T_{on_max} and T_{off_min} values for transmissions

dwelt time: time period equipment is transmitting in one hopping channel before hopping to the next hopping channel

NOTE: Dwell time is always a small fraction of the transmission duration.

epoch: value of 4 times the dwell time multiplied by the number of hopping channels

effective radiated power (e.r.p.): power radiated in the direction of the maximum field strength under specified conditions of measurement, , expressed as the power delivered to a half wave dipole antenna to produce the same field strength

frequency agility: capability of an equipment to dynamically change operating channel

Frequency Hopping Spread Spectrum (FHSS): technique in which the transmission occupies, in predefined hopping sequence, a number of operating channels, each for the dwell time

NOTE 1: For the purpose of the present document, non-overlapping channels are assumed.

NOTE 2: Transmitter and receiver follow the same hopping sequence.

hopping sequence: series of operating channels used to spread a transmission in the frequency domain

NOTE: Operating channels in a hopping sequence are named "hopping channels".

integral antenna: permanent fixed antenna, which may be built-in, designed as an indispensable part of the equipment

Listen Before Transmit (LBT): mechanism by which an equipment applies Clear Channel Assessment (CCA) before transmission (also known as Listen Before Talk)

maintenance: process of external intervention intended to keep equipment operational

NOTE: Maintenance may be scheduled or in response to failure. Automatic processes by the equipment itself are not considered maintenance.

manufacturer: As given in article 2 of Directive 2014/53/EU [i.2].

maximum transmission duration (T_{On-Max}): longest permitted transmission T_{on}

mean power: power supplied to a load (e.g. antenna) averaged over an interval of time sufficiently long compared with the lowest frequency encountered in the modulation

Message Initiator (MI): equipment which generates a message to be transferred to another equipment, such as a Message Responder

Message Responder (MR): equipment which receives a message from another equipment, such as a Message Initiator

minimum inter-transmission interval ($T_{off-min}$): minimum time interval in a channel between two transmissions by the same equipment

nominal operating frequency: frequency at mid-point of the Operating Channel

non-specific use: any type of application

observation bandwidth (F_{obs}): bandwidth in which the energy of an equipment is considered for the purposes of assessing transmission timings

observation period (T_{obs}): reference interval of time

Occupied BandWidth (OBW): width of a frequency band such that, below the lower and above the upper frequency limits, the mean powers emitted are each equal to 0,5 % of the total mean power of a given emission

NOTE 1: Lower and upper frequency edges values of occupied bandwidth are denoted as $FOBW_{low}$ and $FOBW_{high}$.

NOTE 2: See Figure 3.

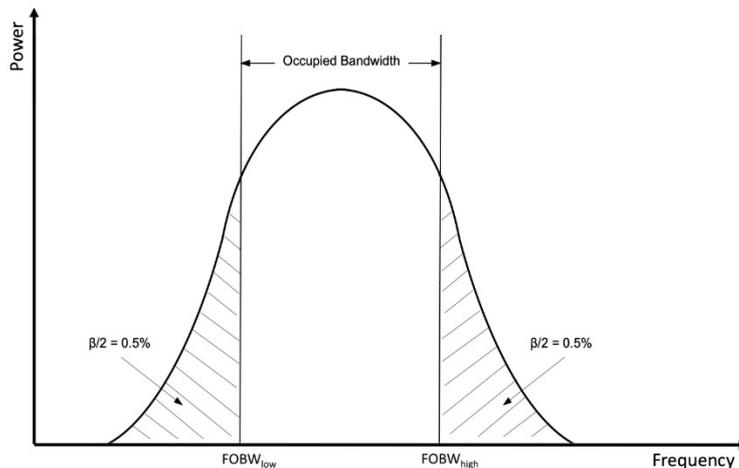


Figure 3: Emission occupied bandwidth

off time (T_{off}): time duration between two successive transmissions in the same operating channel

NOTE: See Figure 4.

on time (T_{on}): duration on a Transmission

NOTE: See Figure 4.

Operating Channel (OC): frequency range in which the transmission occurs

NOTE: Lower and upper frequency edges values of OC are denoted as FOC_{low} and FOC_{high} .

Operating Channel Width (OCW): difference (in Hertz) between the two frequencies FOC_{high} and FOC_{low}

Out Of Band domain (OOB): frequency range immediately outside the operating channel which may contain emissions resulting from the modulation process

out of band emissions: emissions in the out of band domain

Permitted Frequency Band (PFB): frequency band or sub-band within which the equipment is authorized to operate and to perform its intended function

polite spectrum access: techniques to access spectrum and mitigate interference that employ CCA

radiated measurements: measurements which involve the absolute measurement of a radiated field

return time: maximum period of time within which a specific hopping channel is reused

receiver sensitivity: minimum level of the signal at the receiver input, at the nominal operating frequency of the receiver, which produces a specified level of performance

signal threshold ($P_{threshold}$): power level that determines the start and the end of an emission

unwanted emissions: emissions on a frequency or frequencies outside the operating channel

SINAD: (Signal + Noise + Distortion) over (Noise + Distortion)

spurious emissions: emissions on a frequency or frequencies which are outside the operating channel and out of band domain and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products, but exclude out of band emissions

transient power: power falling into frequencies other than the operating channel due to the switching on or off of a transmitter

transmission: continuous radio emission, or sequence of emissions each separated by an interval shorter than $T_{\text{Disregard}}$, with a signal level greater than the signal threshold $P_{\text{threshold}}$ in the operating channel

NOTE: See Figure 4.

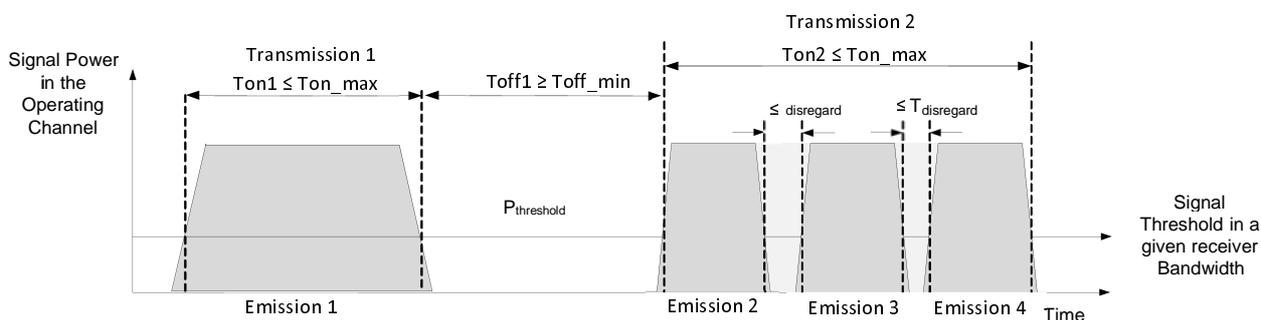


Figure 4: Illustration of two different type of transmissions

3.2 Symbols

For the purposes of the present document, the following symbols apply:

dB	deciBel
dBc	decibel related to peak carrier power
S	sensitivity of receiver in dBm

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

AC	Alternative Current
ACK	Acknowledgment
ACP	Adjacent Channel Power
ACS	Adjacent Channel Selectivity
AFA	Adaptive Frequency Agility
AVG	Average
BER	Bit Error Ratio
BW	BandWidth
CCA	Clear Channel Assessment
CISPR	International Special Committee on Radio Interference
DC	Duty Cycle
DCT	Duty Cycle Template
DSO	Digital Storage Oscilloscope
DSSS	Direct Sequence Spread Spectrum
e.r.p.	Effective Radiated Power
EU	European Union
EUT	Equipment Under Test

FAR	Fully Anechoic Room
FB _{high}	Permitted Frequency Band upper edge
FB _{low}	Permitted Frequency Band lower edge
FHSS	Frequency Hopping Spread Spectrum
FOBW _{low}	Lower Frequency edge of Occupied Bandwidth
FOBW _{high}	Upper Frequency edge of Occupied Bandwidth
FOC _{low}	Frequency Operating Channel lower edge
FOC _{high}	Frequency Operating Channel upper edge
f _{nom}	Nominal operating frequency
FSK	Frequency Shift Keying
GFSK	Gaussian Frequency Shift Keying
ITU-T	International Telecommunication Union - Telecommunication Standardization Sector
LBT	Listen Before Talk
LDC/HR	Low Duty Cycle/High Reliability
LO	Local Oscillator
LPDA	Logarithmic Periodic Dipole Antenna
MSR	Message Success Ratio
NRI	National Radio Interface
OATS	Open Area Test Site
OBW	Occupied BandWidth
OBW _{high}	Highest occupied bandwidth over the environmental profile
OC	Operating Channel
OCW	Operating Channel Width
OFDM	Orthogonal Frequency Division Modulation
OOB	Out Of Band
PD	Power Density
PFB	Permitted Frequency Band
Ppm	Parts per million
QAM	Quadrature Amplitude Modulation
RBW	Resolution BandWidth
RBW _{REF}	REference Resolution BandWidth
RF	Radio Frequency
RMS	Root Mean Square
Rx	Receiver
SAR	Semi-Anechoic Room
SNR	Signal to Noise Ratio
SRD	Short Range Device
TR	Technical Report
Tx	Transmitter
UWB	Ultra Wide Band
VBW	Video BandWidth
VSWR	Voltage Standing Wave Ratio

4 Technical requirements specifications

4.1 Environmental profile

The technical requirements of the present document apply under the environmental profile for operation of the equipment, which shall be in accordance with its intended use. The equipment shall comply with all the technical requirements of the present document at all times when operating within the boundary limits of the operational environmental profile defined by its intended use.

4.2 General conditions for operating

4.2.1 Wanted performance criteria

For the purpose of a digital receiver performance tests, the receiver shall produce a raw data signal with a Bit Error Ratio of 10^{-3} after demodulation.

NOTE: Bit error ratio can be computed from the Message Success Ratio (MSR) by the expression: $MSR = (1-p)^n$ where p is the probability of a single bit error (10^{-3}) and n is the number of bits in the message.

For the purpose of an analogue receiver performance test, the wanted performance criteria is a SINAD ratio of 20 dB, measured at the receiver output.

4.2.2 General conditions

When Radio equipment intends to operate in a Permitted Frequency Band selected from Table 2:

- the equipment shall comply with all parameters, exclusions and notes from the corresponding row in Table 2;
- otherwise:
 - the present document shall be used in conjunction with a National Radio Interface in which radio parameters limits are defined.

NOTE 1: Where such NRI has been applied there may be restrictions on the use of equipment in some countries.

NOTE 2: The use of National Radio Interface parameters different from EU and EFTA member states frequency plan does not provide presumption of conformity to Directive 2014/53/EU [i.5], article 3.2 even if the harmonised standard is cited in the Official Journal of the European Union under that Directive.

4.2.3 Operating conditions

Where the Permitted Frequency Band (PFB) is not divided into channels by regulation (See clause 4.2.4, Table 2), Operating Channel(s) (OC) shall be such that:

- They lie entirely within the PFB.
- In the case of FHSS or AFA, they do not overlap.
- The Nominal Operating Frequency (f_{nom}) is the mid-point of the OC.

Operating conditions shall be as given in Table 1

Table 1: Equipment Operating conditions

Parameter	Value
Operating Channel lower edge frequency	$FOC_{low} \geq FB_{low}$
Operating Channel upper edge frequency	$FOC_{high} \leq FB_{high}$
Operating Channel Width	$OCW = FOC_{high} - FOC_{low}$
Nominal Operating Frequency	$f_{nom} = FOC_{low} + \frac{OCW}{2}$
Operating channels edges of equipment using FHSS or AFA techniques	$FOC_{high}(n) \leq FOC_{low}(n+1)$ for any operating channels. See note.
NOTE: $FOC_{high}(n)$ and $FOC_{low}(n+1)$ represent two consecutive operating channels edges numbered as n and n+1.	

4.2.4 Operating frequency bands and limits

The present document covers equipment operating in the following frequency bands with their technical parameters as described in Table 2.

Table 2: Equipment Operating frequency bands and technical parameters

Permitted Frequency Band		Maximum effective radiated power, e.r.p.	Channel access and occupation rules (e.g. Duty cycle or LBT + AFA)	Maximum occupied bandwidth
A	26,957 MHz to 27,283 MHz	10 mW e.r.p.	No requirement	326 kHz
B	26,99 MHz to 27,00 MHz 27,04 MHz to 27,05 MHz 27,09 MHz to 27,00 MHz 27,14 MHz to 27,15 MHz 27,19 MHz to 27,20MHz	100 mW e.r.p.	≤ 0,1 % duty cycle except for model control where there is no requirement	10 kHz
C	40,660 MHz to 40,700 MHz	10 mW e.r.p.	No requirement	40 kHz
D	169,400 MHz to 169,475 MHz	500 mW e.r.p.	≤ 1,0 % duty cycle For metering equipment duty cycle limit is 10 %	50 kHz
E	169,4000 MHz to 169,4875 MHz	10 mW e.r.p.	≤ 0,1 % duty	87,5 kHz
F	169,4875 MHz to 169,5875 MHz	10 mW e.r.p.	≤ 0,001 % duty cycle except for 00:00 h to 06:00 h local time where the duty cycle limit is ≤ 0,1 %	100 kHz
G	169,5875 MHz to 169,8125 MHz	10 mW e.r.p.	≤ 0,1 % duty cycle	225 kHz
H	433,050 MHz to 434,790 MHz	10 mW e.r.p.	≤ 10 % duty cycle	1,74 MHz
I	433,050 MHz to 434,790 MHz	1 mW e.r.p. -13 dBm/10 kHz power spectral density for bandwidth modulation larger than 250 kHz	No requirement	1,74 MHz
J	434,040 MHz to 434,790 MHz	10 mW e.r.p.	No requirement	25 kHz
K0	862 MHz to 863 MHz	25 mW e.r.p.	≤ 0,1 % duty cycle	350 kHz
K	863 MHz to 865 MHz	25 mW e.r.p.	≤ 0,1 % duty cycle or polite spectrum access	2 MHz
L	865 MHz to 868 MHz	25 mW e.r.p.	≤ 1 % duty cycle or polite spectrum access	3 MHz
M	868,000 MHz to 868,600 MHz	25 mW e.r.p.	≤ 1 % duty cycle or polite spectrum access	600 kHz
N	868,700 MHz to 869,200 MHz	25 mW e.r.p.	≤ 0,1 % duty cycle or polite spectrum access	500 kHz
O	869,400 MHz to 869,650 MHz	500 mW e.r.p.	≤ 10 % duty cycle or polite spectrum access	250 kHz
P	869,700 MHz to 870,000 MHz	5 mW e.r.p.	No requirement	300 kHz
Q	869,700 MHz to 870,000 MHz	25 mW e.r.p.	≤ 1 % duty cycle or polite spectrum access	300 kHz
R	34,995 MHz to 35,225 MHz	100 mW e.r.p.	No requirement Only for flying models	10 kHz
S	40,66 MHz to 40,67 MHz, 40,67 MHz to 40,68 MHz, 40,68 MHz to 40,69 MHz, 40,69 MHz to 40,70 MHz	100 mW e.r.p.	No requirement Only for model control	10 kHz
T	138,20 MHz to 138,45 MHz	10 mW e.r.p.	≤ 1,0 % duty cycle	250 kHz
V	863 MHz to 870 MHz	25 mW e.r.p. except in the alarm frequency bands: 868,6 - 868,7 MHz, 869,2 - 869,4 MHz, 869,65 - 869,7 MHz where transmission is not allowed.	≤ 0,1 % duty cycle The duty cycle applies to the entire transmission (not to each hop channel) Minimum of 47 channels	100 kHz

Permitted Frequency Band		Maximum effective radiated power, e.r.p.	Channel access and occupation rules (e.g. Duty cycle or LBT + AFA)	Maximum occupied bandwidth
W	863 MHz to 870 MHz	25 mW e.r.p. Power spectral density: -4,5 dBm/100 kHz. except in the alarm frequency bands: 868,6 - 868,7 MHz, 869,2 - 869,4 MHz, 869,65 - 869,7 MHz where transmission is not allowed.	≤ 0,1 % duty cycle or polite spectrum access	7 MHz
X	870,000 MHz to 874,400 MHz	25 mW e.r.p.	≤ 1 % duty cycle For ER-GSM protection (873 MHz to 875,8 MHz, where applicable), the duty cycle is limited to ≤ 0,01 % and T_{on-max} is limited to 5 ms/1 s	600 kHz
Y	915,000 MHz to 919,400 MHz	25 mW e.r.p. except for the 4 channels for the 4 channels identified in channel with centre frequencies at 916,3 MHz, 917,5 MHz, 918,7 MHz and 919,9 MHz, where 100 mW e.r.p. applies.	≤ 1 % duty cycle For ER-GSM protection (918 MHz to 920,8 MHz, where applicable), the duty cycle is limited to ≤ 0,01 % and T_{on-max} is limited to 5 ms/1 s	600 kHz except for the 4 channels identified in channel with centre frequencies at 916,3 MHz, 917,5 MHz, 918,7 MHz and 919,9 MHz. where the bandwidth is limited to 400 kHz

4.3 All equipment conformance requirements

4.3.1 Unwanted emissions in the spurious domain

4.3.1.1 Applicability

Unwanted emissions in the spurious domain requirement shall apply to all equipment.

4.3.1.2 Description

4.3.1.2.1 Unwanted emissions for a Tx mode

Spurious emissions are unwanted emissions in the spurious domain at frequencies other than those of the Operating Channel and the Out Of Band Domain. The spurious domain is shown for illustration in Figure 5.

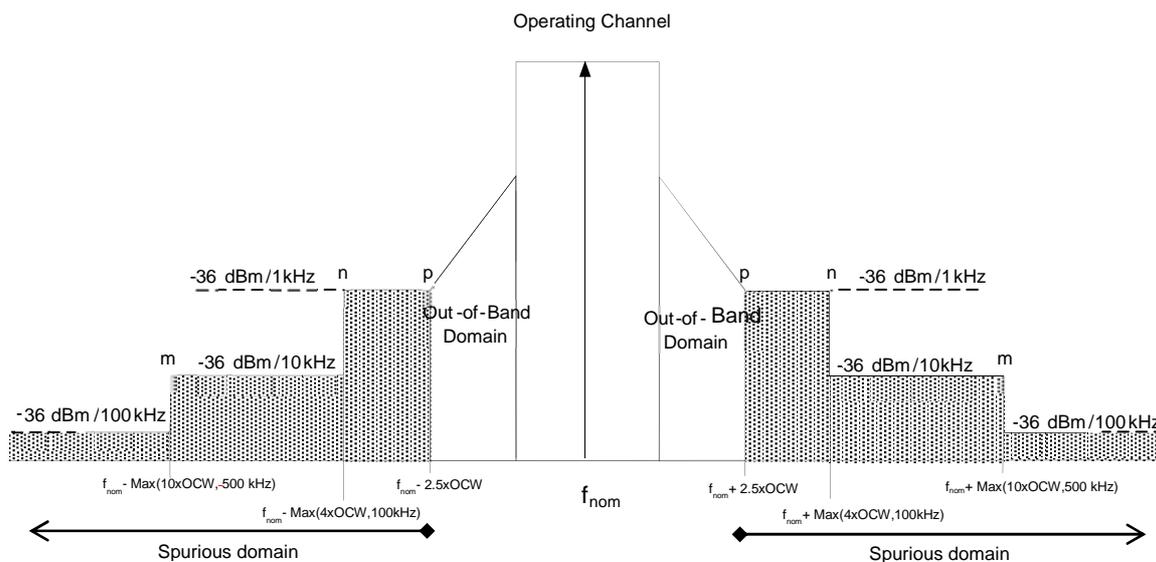


Figure 5: Illustration of spectrum mask for unwanted emissions in the spurious domain with reference BW

4.3.1.2.2 Unwanted emissions for all other modes

Spurious radiations from the equipment are components, at any frequency, radiated by equipment and antenna.

4.3.1.3 Limits

The mean power of any unwanted emission in the spurious domain shall not exceed the values given in Table 3.

Table 3: Spurious domain emission limits

Frequency	87,5 MHz to 118 MHz 174 MHz to 230 MHz 470 MHz to 694 MHz	Other frequencies below 1 000 MHz	Frequencies above 1 000 MHz
State			
Tx mode	-54 dBm	-36 dBm	-30 dBm
Rx and all other modes	-57 dBm	-57 dBm	-47 dBm

NOTE: Source of Table 3 value is ERC Recommendation 74.01[i.13], Annex 2, Table 6.

4.3.1.4 Conformance

The conformance test suite for the unwanted emission in the spurious domain under normal test condition shall be as defined in clause 5.3.1 of the present document.

4.4 Transmitter conformance requirements

4.4.1 Effective Radiated Power

4.4.1.1 Applicability

The effective radiated power requirement shall apply to all transmitters.

4.4.1.2 Description

The effective radiated power (e.r.p.) is the power radiated in the direction of the maximum radiated power under specified conditions of measurements for any condition of modulation.

4.4.1.3 Limits

The effective radiated power shall not be greater than the value allowed in Table 2 for the permitted frequency band(s) or in NRI.

4.4.1.4 Conformance

The conformance test suite for the effective radiated power requirement under normal and extreme test condition shall be as defined in clause 5.4.1 of the present document.

4.4.2 Maximum e.r.p. power spectral density

4.4.2.1 Applicability

The maximum e.r.p. power spectral density requirement shall apply to transmitters operating in Table 2 bands I.

Maximum e.r.p. power spectral density shall apply to transmitters using DSSS or wideband techniques other than FHSS modulation operating in Table 2 band W.

Maximum e.r.p. power spectral density shall apply to transmitters when requested by the intended PFB in NRI.

4.4.2.2 Description

The maximum e.r.p. spectral density is defined as the highest e.r.p. level in dBm per Hertz generated by the transmitter within the power envelope.

4.4.2.3 Limits

The Maximum e.r.p. power spectral density shall not be greater than the value allowed in Table 2 or in NRI for the Permitted Frequency Band(s).

4.4.2.4 Conformance

The conformance tests for this requirement under normal and extreme test condition shall be as in clause 5.4.2 of the present document.

4.4.3 Duty Cycle

4.4.3.1 Applicability

The duty cycle requirement shall apply to all transmitters except equipment operating in bands K, L, M, N, O, Q or W using polite spectrum access (described in clause 4.6).

4.4.3.2 Description

Duty cycle is the ratio expressed as a percentage, of the cumulative duration of transmissions T_{on_cum} within an observation interval T_{obs} . $DC = \left(\frac{T_{on_cum}}{T_{obs}} \right)_{F_{obs}}$ on an observation bandwidth F_{obs} .

Unless otherwise specified, T_{obs} is 1 hour and the observation bandwidth F_{obs} is the Permitted Frequency Band.

Each transmission consists of an RF emission, or sequence of RF emissions separated by intervals $< T_{disregard}$.

An equipment may operate on several bands simultaneously (i.e. multi transmissions), the Duty Cycle limit of each individual band applies to the series of transmissions within that band.

In case of a multicarrier modulation in an operating channel, the duty cycle applies to the whole signal used for a transmission (e.g. OFDM).

NOTE: In some bands the Duty Cycle value may depend on the presence of a primary radio service.

Equipment may be triggered manually, by internal timing or by external stimulus. Depending on the method of triggering the timing may be predictable or random.

4.4.3.3 Limits

The Duty Cycle at any operating frequency shall not be greater than the duty cycle value as specified Table 2 or in NRI for the permitted frequency band(s).

4.4.3.4 Conformance

The conformance test to duty cycle requirement under normal test condition shall be as defined in clause 5.4.3 of the present document.

4.4.4 Maximum occupied bandwidth

4.4.4.1 Applicability

The maximum occupied bandwidth requirement shall apply to all transmitters.

4.4.4.2 Description

The occupied bandwidth is the frequency range in which 99 % of the total mean power of a given emission falls. The residual part of the total power being denoted as β , splits up into $\beta/2$ on each side of the spectrum. Unless otherwise specified, $\beta/2$ is taken as 0,5 % as described in Figure 3.

4.4.4.3 Limits

The highest occupied bandwidth value at 99 % over the environmental profile (OBW_{high}) shall not exceed maximum occupied bandwidth value specified in Table 2 or in NRI for the permitted frequency band(s).

4.4.4.4 Conformance

The conformance test suite for occupied bandwidth requirement under normal and extreme test condition shall be as defined in clause 5.4.4 of the present document.

4.4.5 Transmitter frequency stability

4.4.5.1 Applicability

The transmitter frequency stability requirement shall apply to all transmitters.

4.4.5.2 Description

Frequency stability impacts the ability of the radio transmitter to occupy, in all specified operating conditions in the environmental profile, a bandwidth smaller than or equal to its Operating Channel.

NOTE: As the present document addresses non specific SRDs with a wide variety of OCW values, the limit is expressed in frequencies instead of the usual ppm value of f_{nom} .

4.4.5.3 Limits

The transmission signal at any operating frequency(ies) shall reside entirely within the Operating Channel(s) over the environmental profile.

Limits are specified in Table 4.

Table 4: Transmitter frequency stability limits

Limits at any operating frequency
$FOC_{low} \leq \text{Min FOBW}_{low}$
$\text{Max FOBW}_{high} \leq FOC_{high}$
With FOC_{low} : operating channel lower frequency edge. FOC_{high} : operating channel upper frequency edge. Min FOBW_{low} : lowest lower frequency edge of occupied bandwidth over environmental profile. Max FOBW_{high} : highest upper frequency edge of occupied bandwidth over environmental profile. OBW , FOC_{low} , FOC_{high} as specified in clause 4.2.3.

4.4.5.4 Conformance

The conformance test suite for the operating frequencies requirement under normal and extreme test conditions shall be as defined in clause 5.4.5 of the present document.

4.4.6 Transmitter out of band emissions

4.4.6.1 Applicability

The Tx Out of Band emissions requirement shall apply to all transmitters with $OCW > 25$ kHz.

NOTE: For equipment with $OCW \leq 25$ kHz, the adjacent channel power clause 4.4.7 applies instead.

4.4.6.2 Description

Unwanted emissions in the Out Of Band domain are those falling in the frequency range immediately below the lower, and above the upper frequency edges of Operating Channel up to 2,5 times Operating Channel Width.

The OOB domain spectrum mask is illustrated in Figure 6.

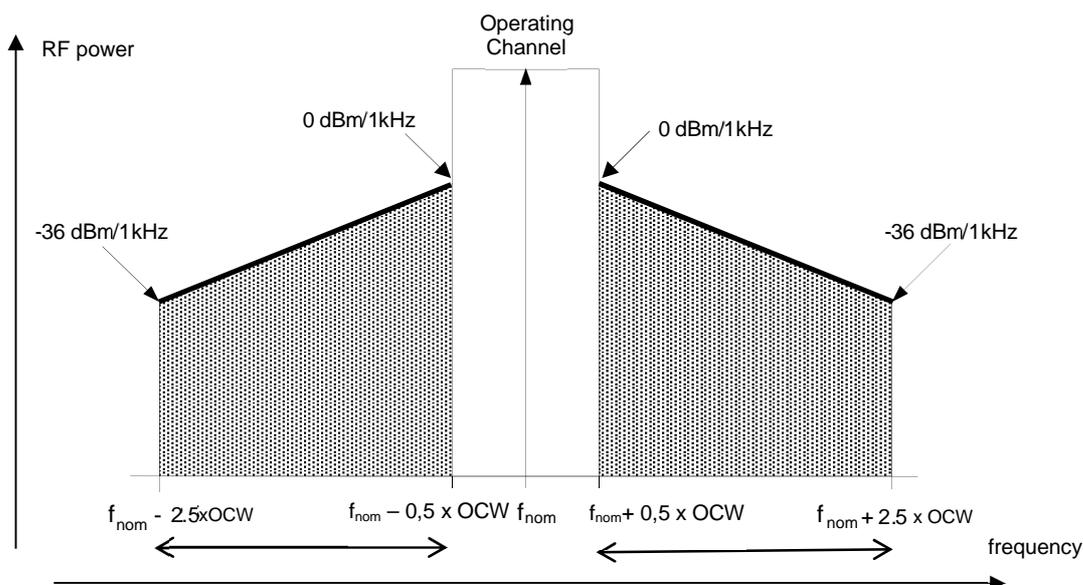


Figure 6: Illustration of Out Of Band Domain limits with reference BW

4.4.6.3 Limits

The emissions level in the Out Of Band domain shall be less than or equal to the limits given in Table 5.

Table 5: Emission limits in the Out Of Band domain

Frequency Range	Maximum power limit	RBW _{REF}
$f = f_{\text{nom}} - 2,5 \times \text{OCW}$	-36 dBm	1 kHz
$f_{\text{nom}} - 2,5 \times \text{OCW} \leq f \leq f_{\text{nom}} - 0,5 \times \text{OCW}$	$36 \times (f_{\text{[MHz]}} - f_{\text{nom [MHz]}} + 0,5 \times \text{OCW}_{\text{[MHz]}}) / (2 \times \text{OCW}_{\text{[MHz]}})$ dBm	1 kHz
$f = f_{\text{nom}} - 0,5 \times \text{OCW}$	0 dBm	1 kHz
$f = f_{\text{nom}} + 0,5 \times \text{OCW}$	0 dBm	1 kHz
$f_{\text{nom}} + 0,5 \times \text{OCW} \leq f \leq f_{\text{nom}} + 2,5 \times \text{OCW}$	$-36 \times (f_{\text{[MHz]}} - f_{\text{nom [MHz]}} - 0,5 \times \text{OCW}_{\text{[MHz]}}) / (2 \times \text{OCW}_{\text{[MHz]}})$ dBm	1 kHz
$f = f_{\text{nom}} + 2,5 \times \text{OCW}$	-36 dBm	1 kHz
NOTE: f is the measurement frequency. f_{nom} is the nominal operating frequency. OCW is the Operating Channel Width as defined in clause 4.2.3.		

4.4.6.4 Conformance

The conformance test suite for Tx out of band emission requirement under normal test conditions shall be as defined in clause 5.4.6 of the present document.

4.4.7 Adjacent Channel Power

4.4.7.1 Applicability

The adjacent channel power requirement shall apply to all transmitters with $\text{OCW} \leq 25$ kHz.

NOTE: For equipment with $\text{OCW} > 25$ kHz, the Tx out of band emissions clause 4.4.6 applies instead.

4.4.7.2 Description

Adjacent channel power is power incidental to proper operation of a transmitter falling into the adjacent and alternate channels.

4.4.7.3 Limits

The power in the adjacent channels shall not exceed the values given in Table 6.

Table 6: Adjacent channel power limits for transmitters with OCW \leq 25 kHz

Adjacent Channel power integrated over 0,7 x OCW	Alternate Channel power integrated over 0,7 x OCW
-15 dBm	-20 dBm

4.4.7.4 Conformance

The conformance test suite for adjacent channel power requirement under normal test conditions shall be as defined in clause 5.4.7 of the present document.

4.4.8 Transmitter spectrum mask at permitted frequency band edges

4.4.8.1 Applicability

The Tx spectrum mask at permitted frequency band edges requirement shall apply to all transmitters.

4.4.8.2 Description

Specific limits apply at frequencies immediately above and below the Permitted Frequency Band edges as illustrated in Figure 7.

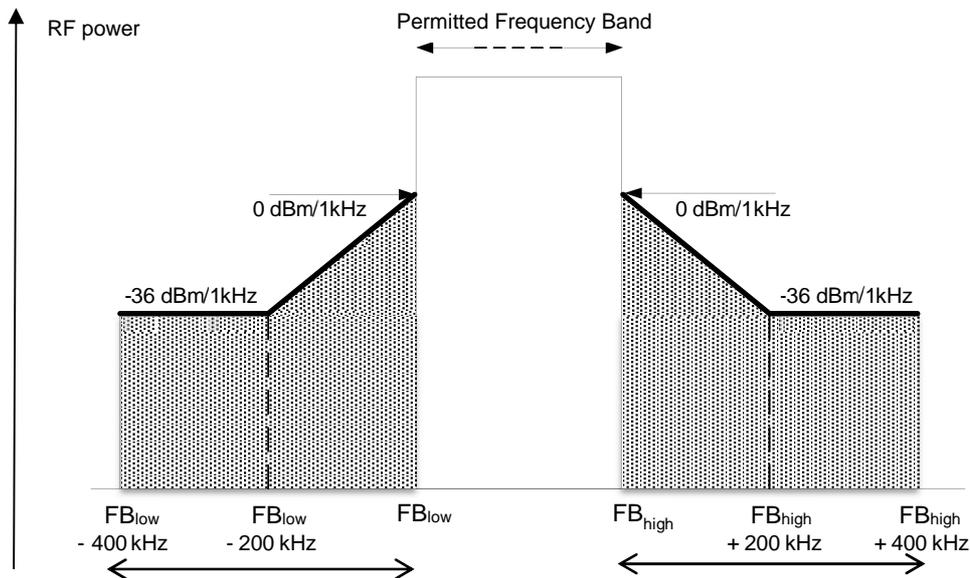


Figure 7: Illustration of spectrum mask at permitted frequency band edges with reference BW

NOTE: FB_{low} is the lower edge of the permitted frequency band.

FB_{high} is the upper edge of the permitted frequency band.

4.4.8.3 Limits

The emissions level at band edges shall be less than or equal to the limits given in Table 7.

Table 7: Emission limits in at the band edges

Frequency Range	Maximum power limit	RBW _{REF}
$FB_{low} - 400 \text{ kHz} \leq f \leq FB_{low} - 200 \text{ kHz}$	-36 dBm	1 kHz
$FB_{low} - 200 \text{ kHz} \leq f \leq FB_{low}$	$180 \times (f_{[MHz]} - FB_{low [MHz]}) \text{ dBm}$	1 kHz
$f = FB_{low}$	0 dBm	1 kHz
$f = FB_{high}$	0 dBm	1 kHz
$FB_{high} \leq f \leq FB_{high} + 200 \text{ kHz}$	$-180 \times (f_{[MHz]} - FB_{high [MHz]}) \text{ dBm}$	1 kHz
$FB_{high} + 200 \text{ kHz} \leq f \leq FB_{high} + 400 \text{ kHz}$	-36 dBm	1 kHz
NOTE: f is the measurement frequency. FB _{low} is the lower edge of the operating frequency band. FB _{high} is the upper edge of the operating frequency band.		

4.4.8.4 Conformance

The conformance test suite for Tx spectrum mask at frequency band edges requirement under normal test conditions shall be as defined in clause 5.4.8 of the present document.

4.4.9 Transient power

4.4.9.1 Applicability

The transient power requirement shall apply to all transmitters.

4.4.9.2 Description

Transmitter transient power is power falling into frequencies other than the operating channel as a result of the transmitter being switched on and off.

4.4.9.3 Limits

The transient power shall not exceed the values given in Table 8.

Table 8: Transmitter Transient Power limits

Absolute offset from nominal operating frequency	RBW _{REF}	Peak power limit applicable at measurement points
$\leq 400 \text{ kHz}$	1 kHz	0 dBm
$> 400 \text{ kHz}$	1 kHz	-27 dBm

4.4.9.4 Conformance

The conformance test suite for transient power requirement under normal test conditions shall be as defined in clause 5.4.9 of the present document.

4.4.10 Transmitter behaviour under Low Voltage Conditions

4.4.10.1 Applicability

The Tx behaviour under low voltage condition requirement shall apply to battery powered equipment.

4.4.10.2 Description

The Tx behaviour under low voltage condition is the ability of equipment to maintain its operating frequency and not produce emissions which exceed any relevant limit for any voltage below the lower extreme voltage level given by the environmental profile.

4.4.10.3 Limits

The equipment shall either:

- a) remain in the Permitted Frequency Band without exceeding any applicable limits (e.g. Duty Cycle); or
- b) reduce its effective radiated power below the spurious emission limits without exceeding any applicable limits (e.g. Duty Cycle); or
- c) shut down, (ceasing function);

as the voltage falls below the lowest voltage level in the environmental profile.

4.4.10.4 Conformance

The conformance test suite for Tx behaviour under low voltage condition requirement under normal test conditions shall be as defined in clause 5.4.10 of the present document.

4.4.11 FHSS equipment

4.4.11.1 Applicability

The FHSS requirements shall apply to all equipment using FHSS technique transmitting in band V as defined in Table 2.

4.4.11.2 Description

Frequency Hopping Spread Spectrum is a technique where each transmission is spread over multiple Operating Channels known as hopping channels.

For equipment using FHSS technique, the duty cycle applies to the entire transmission, not at each hopping channel.

4.4.11.3 Limits

FHSS equipment shall meet the following limits:

- a) FHSS equipment shall not transmit in alarm systems sub-bands as specified in Table 2 for band V.
- b) The number of hopping channels shall be greater than or equal to the values given in Table 2 for band V.
- c) Transmission in the alarm frequency bands: 868,6 - 868,7 MHz, 869,2 - 869,4 MHz, 869,65 - 869,7 MHz is not allowed.
- d) The dwell time shall not exceed 400 ms.
- e) For FHSS transmissions with a dwell time less than 10 ms, duty cycle shall be less than 0,1 %.
- f) Each hopping channel of the hopping sequence shall be occupied at least once during an epoch.
- g) The return time to a hopping channel shall be less than or equal to the lowest value of an epoch or 20 seconds.
- h) If CCA is used, the following requirements apply:
 - h1) CCA shall be applied
 - at each hopping channel; or

- on the first hopping channel corresponding to frame preamble transmissions. In this case the Duty Cycle limit applies to the remainder of the FHSS Transmission, i.e. preamble excluded.

h2) Clause 4.6.2 shall apply.

4.4.11.4 Conformance

The conformance test suite for FHSS requirement shall be as defined in clause 5.4.11 of the present document.

4.4.12 Short term behaviour

4.4.12.1 Applicability

The short term behaviour requirement shall apply to equipment operating in Table 2, band X, or band Y where T_{on} or T_{off} limits are specified.

The short term behaviour requirement shall apply to equipment when T_{on} or T_{off} limits are specified in NRI.

4.4.12.2 Description

Each transmission consists of an RF emission, or sequence of RF emissions separated by intervals $< T_{disregard}$, in the operating channel. The EUT cannot exceed a maximum T_{on} value for a continuous transmission and cannot retransmit in the same operating channel without waiting for a minimum period T_{off} .

4.4.12.3 Limits

The short term behaviour shall comply with T_{on} and T_{off} values as specified in Table 2 or in NRI for the permitted frequency band(s) used.

4.4.12.4 Conformance

The conformance test suite for short term behaviour requirement under normal test conditions shall be as defined in clause 5.4.12 of the present document.

4.5 Receivers conformance requirements

4.5.1 Receiver sensitivity

4.5.1.1 Applicability

The Rx sensitivity requirement shall apply to all receivers.

4.5.1.2 Description

The receiver sensitivity is the minimum signal power input to the receiver which produces the wanted performance criterion stated in clause 4.2.1. The test input signal is generated at the nominal operating frequency and modulated with intended modulation.

4.5.1.3 Limits for equipment employing polite spectrum access

The sensitivity level for receivers shall be below or equal to the level in Table 9.

Table 9: Limits for Receiver sensitivity level

$S = 10 \log OCW_{kHz} - 117dBm$
<p>where:</p> <ul style="list-style-type: none"> • S is the sensitivity level in dBm. • OCW is the width of Operating Channel in kHz.

EXAMPLE: The sensitivity level for equipment using a 200 kHz OCW shall be less or equal to -94 dBm.

4.5.1.4 Limits for equipment not employing polite spectrum access

The sensitivity level for receivers shall be below or equal to -50 dBm.

4.5.1.5 Conformance

The conformance test suite for receiver sensitivity under normal test conditions shall be as defined in clause 5.5.1 of the present document.

4.5.2 Receiver dynamic range

4.5.2.1 Applicability

The receiver dynamic range requirement shall apply to all receivers.

4.5.2.2 Description

Dynamic range is the range of input signal between the minimum sensitivity level and the maximum input signal power to the receiver which produces the general performance criteria stated in clause 4.2.1 of the present document.

4.5.2.3 Limits

The Rx dynamic range shall not be less than the limits given in Table 10.

Table 10: Limits for receiver maximum input signal level

Parameter	Limit
Rx dynamic range	≥ 60 dB

4.5.2.4 Conformance

The conformance test suite for the receiver dynamic range requirement under normal test conditions shall be as defined in clause 5.5.2 of the present document.

4.5.3 Adjacent channel selectivity

4.5.3.1 Applicability

The adjacent channel selectivity requirement shall apply to all receivers using bands D and J in Table 2, or other bands where channel spacing is specified in NRI.

4.5.3.2 Description

Adjacent channel selectivity is a measure of the receiver capability to receive a wanted signal without exceeding a given degradation due to the presence of an unwanted input signal in the adjacent channels.

4.5.3.3 Limits

The measured adjacent channel selectivity shall not be less than the value specified in Table 11.

Table 11: Adjacent channel selectivity limit

Parameter	Value
	Wanted signal = S + 3 dB
Adjacent channel selectivity	-69 dBm

4.5.3.4 Conformance

The conformance test suite for the adjacent channel selectivity requirement under normal test conditions shall be as defined in clause 5.5.3 of the present document.

4.5.4 Blocking

4.5.4.1 Applicability

The blocking requirement shall apply to all receivers.

4.5.4.2 Description

Blocking is a measure of the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted input signal at any frequencies other than those of the spurious responses.

NOTE: Spurious response rejection is specified in clause 4.5.5.

4.5.4.3 Limits

The blocking levels at the specified frequency offsets shall be equal to or greater than the limits Table 12.

Table 12: Blocking level limits

Requirement	Limits
Blocking at ± 2 MHz from OC edges FOC_{high} and FOC_{low}	≥ -69 dBm
Blocking at ± 10 MHz from OC edges FOC_{high} and FOC_{low}	≥ -44 dBm
Blocking at ± 5 % Nominal operating frequency or ± 15 MHz, whichever is the greater	≥ -44 dBm

For equipment with CCA, Blocking shall be tested in addition at sensitivity level +16 dB.

4.5.4.4 Conformance

The conformance test suite for the blocking requirement under normal test conditions shall be as defined in clause 5.5.4 of the present document.

4.5.5 Receiver spurious response rejection

4.5.5.1 Applicability

The receiver spurious response rejection requirement shall apply to all receivers.

4.5.5.2 Description

The spurious response rejection requirement is a measure of the capability of the receiver to receive a wanted signal without exceeding a given degradation due to the presence of an unwanted unmodulated signal at any frequency at which a response is obtained. The frequencies of the operating and adjacent channels are excluded.

4.5.5.3 Limits

The measured receiver rejection level for any spurious response shall not be less than the limits given in Table 13. The frequencies of the operating and the adjacent channels are excluded.

Table 13: Receiver spurious response rejection limits

Spurious response frequency offset	Limit
± 2 MHz from OC edges FOC_{high} and FOC_{low}	-79 dBm
< -2 MHz from OC edge FOC_{low} or > 2 MHz from OC edge FOC_{high}	-54 dBm

4.5.5.4 Conformance

The conformance test suite for the receiver spurious response rejection requirement under normal test conditions shall be as defined in clause 5.5.5 of the present document.

4.5.6 Receiver intermodulation rejection

4.5.6.1 Applicability

The receiver intermodulation rejection requirement shall apply to all receivers using bands D or J in Table 2, or other bands where channel spacing is specified in NRI.

4.5.6.2 Description

The intermodulation rejection requirement is a measure of the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of two or more unwanted signals with a specific frequency relationship to the wanted signal.

4.5.6.3 Limits

The measured receiver intermodulation rejection level shall not be less than the limits given in Table 14.

Table 14: Receiver intermodulation rejection limits

Parameter	Limit
Receiver intermodulation rejection	25 dB

4.5.6.4 Conformance

The conformance test suite for the receiver intermodulation rejection requirement under normal test conditions shall be as defined in clause 5.5.6 of the present document.

4.6 Polite spectrum access conformance requirement

4.6.1 Description

4.6.1.0 General

Before transmitting, a polite device senses the operating channel for at least the Clear Channel Assessment interval to determine if it is free of energy. If the average signal level over the clear channel assessment listening interval is below the CCA threshold the device proceeds with the transmission (also called Listen Before Transmit).

If the average signal level is above the signal threshold, the polite device defers its transmission to a later time. The equipment does not attempt a re-transmission on the same operating frequency until a random interval has expired (deferral period) and again starts the listen time before transmission (CCA). Various algorithms may be used to implement polite spectrum access including periodic and event driven decisions to wait or change of speed transmission (Adaptivity) or to change of operating channel (Agility - Also called AFA as described in clause 4.6.1.1). Preferred algorithms distribute generated traffic uniformly over available channels and avoid use of channels occupied permanently or temporarily occupied by other devices.

NOTE: The random interval should be consistent with the duration of transmissions of equipment and may be associated with a contention resolution algorithm provided by medium access protocol specifications.

4.6.1.1 Adaptive Frequency Agility

Further improvements in shared spectrum access can be achieved if Listen Before to Transmit with CCA is combined with frequency agility. If the Operating Channel is not free, equipment may select another operating frequency and again start the listen time before transmission (CCA) assessment.

Although no specific timing constraints are imposed, it should be noted that the delays in switching between receive and transmit states, together with the corresponding processing delays of signals through the receiver and transmitter, should be less than the CCA interval in order to avoid losing the channel to another device.

4.6.2 Clear Channel Assessment threshold

4.6.2.1 Applicability

The clear channel Assessment requirement shall apply to equipment using polite spectrum access instead of duty cycle in bands K, L, M, N, O, Q or U, V,W or when required by the intended PFB in NRI.

4.6.2.2 Description

The CCA threshold is defined as the received signal level above which the EUT determines that the channel is not available for use.

4.6.2.3 Limits

The CCA threshold shall not exceed the limits given in Table 15.

Table 15: CCA radiated threshold limits

Parameter	Value
CCA threshold for equipment with e.r.p < 100 mW	15 dB above Rx sensitivity level limit as given in Table 9
CCA threshold for equipment with e.r.p from 100 mW to 500 mW	11 dB above Rx sensitivity level limit as given in Table 9
NOTE:	The limits are based on an antenna gain of 0 dB relative to a dipole (i.e. +2,15 dBi) maximum. For other antenna gains different to 0 dB the limits shall be adjusted accordingly.
EXAMPLE:	With antenna gain of -5 dB, the CCA threshold shall be corrected and increased by 5 dB at the RF front end.

4.6.2.4 Conformance

The conformance test suite for CCA threshold requirement under normal test conditions shall be as defined in clause 5.6.1 of the present document.

4.6.3 Polite spectrum access timing parameters

4.6.3.1 Applicability

The polite spectrum access timing parameters clause shall apply to equipment using polite spectrum access in bands K, L, M, N, O, Q or U, V,W or when required by the intended PFB in NRI.

4.6.3.2 Limits for polite spectrum access timing parameters

Parameters are shown in Table 16 and their limits shall not be exceeded.

Table 16: Limits for Polite Spectrum Access timing parameters

Parameter	Limit	Notes
Minimum CCA interval	160 μ s	Minimum CCA listening period
Maximum Transmission Duration T_{on} Max	1 s	For a single transmission
Maximum Transmission Duration T_{on} Max	4 s	For a transmission dialogue or a polling sequence
Max T_{cum_on} over 1 hour	100 s/1 h per 200 kHz spectrum	Maximum allowed Cumulative On Time over a 200 kHz portion of spectrum per hour
Minimum T_{off_min} at the same nominal operating frequency	100 ms	The minimum T-off time period where a specific transmitter shall remain off after a transmission on the same nominal operating frequency

NOTE: Longer accumulated transmission time is possible by implementing more AFA channels.

4.6.3.3 Conformance

The conformance test suite for polite spectrum access parameters requirement under normal test conditions shall be as defined in clause 5.6.2 of the present document.

5 Testing for compliance with technical requirements

5.1 Environmental conditions for testing

5.1.1 General consideration

Tests defined in the present document shall be carried out at representative points within the boundary limits of the operational environmental profile defined by its intended use described in annex G.

Where technical performance varies subject to environmental conditions, tests shall be carried out under a sufficient variety of environmental conditions (within the boundary limits of the operational environmental profile defined by its intended use) to give confidence of compliance for the affected technical requirements.

5.1.2 Normal test conditions

5.1.2.1 Normal temperature and humidity

The normal temperature and humidity conditions for tests shall be any convenient combination of temperature and humidity within the following ranges:

- temperature +20 °C to +30 °C
- relative humidity 20 % to 75 %.

5.1.2.2 Normal test power source

5.1.2.2.1 Mains voltage

The normal test voltage for equipment to be connected to the mains shall be the nominal intended mains voltage. The frequency of the test power source corresponding to the ac mains shall be between 49 Hz and 51 Hz.

5.1.2.2.2 Regulated lead-acid battery power sources

When the radio equipment is intended for operation with the usual types of regulated lead-acid battery power source, the normal test voltage shall be 1,1 multiplied by the nominal voltage of the battery (e.g. 6 V, 12 V, etc.).

5.1.2.2.3 Other power sources

For operation from other power sources or types of battery, the normal test voltage is the equipment nominal voltage as given by the intended use. See annex G.

5.1.3 Extreme test conditions

5.1.3.1 Extreme temperature range

Tests at extreme temperatures shall be made in accordance with the boundary limits of the operational environmental profile defined by its intended use given by annex G.

5.1.3.2 Extreme test source voltage

5.1.3.2.1 Mains voltage

The extreme test voltages for equipment to be connected to an AC mains source shall be the nominal mains voltage $\pm 10\%$.

5.1.3.2.2 Regulated lead-acid battery power sources

When the radio equipment is intended for operation from the usual type of regulated lead-acid battery power sources the extreme test voltages shall be 1,3 and 0,9 multiplied by the battery nominal voltage (6 V, 12 V, etc.) which is provided by annex G.

For "gel-cell" type batteries the extreme voltage shall be 1,15 and 0,85 multiplied by the battery nominal voltage, which is provided by annex G.

5.1.3.2.3 Other power sources

For operation from other power sources or types of battery, the extreme test voltage is given by the intended use as provided by annex G.

5.2 General conditions for testing

5.2.1 General considerations

Technical documentation and operating manuals, sufficient to allow testing to be performed, shall be provided along with the EUT and any companion equipment necessary for its intended use. Annex G identifies various EUT properties required by the test suites specified in the present document.

For devices having several nominal operating frequencies but identical OCW, measurements shall be performed on the lowest and the highest nominal operating frequencies. This is intended to give confidence that the requirements set out in the present document have been met without the necessity of performing measurements on all frequencies.

For devices having several nominal operating frequencies with different OCW, measurements shall be performed at all operating frequencies.

5.2.2 Presentation of equipment for testing purposes

5.2.2.1 General Considerations

5.2.2.1.1 General

EUT shall be tested complete.

5.2.2.1.2 EUT with an external RF connector

EUT with an external RF connector offered for testing shall provide a 50 Ω connector for conducted RF power measurements.

5.2.2.1.3 EUT without an external RF connector

5.2.2.1.3.1 General Considerations

Conducted measurements on an EUT with an integral antenna or with an antenna connection other than a 50 Ω coaxial connector may be made by:

- access to an internal connector; or
- fitting of a temporary connector with addition of a 20 dB attenuator, if no internal connector is available; or
- use of a test fixture if none of above possibilities are available.

5.2.2.1.3.2 EUT with an internal connector

Where the EUT has an internal 50 Ω coaxial connector between the antenna and the circuitry, this may be utilized to perform conducted measurements. Use of an internal antenna connection shall be recorded in the test report.

5.2.2.1.3.3 EUT with a temporary antenna connector

One EUT, with the dedicated antenna connected or integral antenna, shall be tested using radiated measurement procedures. For relative measurements, two EUTs may be submitted to the test laboratory, one fitted with a temporary antenna connector mounted on the Printed Circuit Board with the antenna disconnected and another with the antenna connected. The EUT with integral antenna shall be used for radiated measurements. The second EUT with the temporary connector can only be used for RF power relative measurements or other measurements not related to RF power (e.g.: Polite spectrum access timing parameters). The two EUTs shall be identical in all respects except for the temporary antenna connector.

Use of an EUT with a temporary antenna connection shall be recorded in the test report.

5.2.2.1.3.4 Use of a Test Fixture

A test fixture is a structure for coupling an EUT with an integral antenna, at all frequencies for which measurements need to be performed, to a 50 Ω RF terminal.

A test fixture can be used only if no internal or temporary connector is available and only for relative measurements.

For further information on the test fixture, see annex E.

5.2.2.2 Testing of modular equipment

If a family of equipment has alternative output power levels provided by the use of separate power modules or add on stages, then each module or add on stage shall be tested in combination with the EUT over each applicable permitted frequency band.

5.2.3 Test power source

5.2.3.1 General

The equipment shall be tested using test power source as specified in clauses 5.2.3.2 or 5.2.3.3. Where equipment is intended to be powered using either external or internal power sources, then the equipment shall be tested using the external power source as specified in clause 5.2.3.2. then repeated using the internal power source as specified in clause 5.2.3.3.

The test power source used shall be stated in the test report.

5.2.3.2 External test power source

External test power sources shall be capable of producing test voltages as specified in the environmental profile. The internal impedance of the external test power source shall be low enough for its effect on the test results to be negligible. For the purpose of the tests, the voltage of the external test power source shall be measured at the input terminals of the equipment. Note that this may be the mains connection point for equipment supplied with an external power supply. The external test power source shall be de-coupled and applied immediately at the equipment battery terminals.. For radiated measurements, any external power cable shall be equipped with ferrite bead which shall present an impedance of at least 100 Ω at 100 MHz.

5.2.3.3 Internal test power source

For radiated measurements on portable equipment with integral or dedicated antenna, fully charged internal batteries shall be used. The batteries used shall be as supplied or recommended by the manufacturer. If internal batteries are used, at the end of each test the voltage shall be within 5 % of the voltage at the beginning of each test. Where this is not possible, clause D.3.1 applies.

5.2.4 Thermal test conditions

Before measurements are made the equipment shall have reached thermal balance in the test chamber. The equipment shall be switched off during the temperature stabilizing period.

In the case of equipment containing temperature stabilization circuits designed to operate continuously, the temperature stabilization circuits shall be powered on for 15 minutes after thermal balance has been obtained, and the equipment shall then meet the specified requirements.

If the thermal balance cannot be checked by measurements, EUT shall respect a temperature stabilizing period of one hour. The sequence of measurements shall be set, and the humidity content in the test chamber shall be controlled in order that condensation does not occur.

5.2.5 Testing of frequency agile or hopping equipment

The transmission channels of EUT with AFA and hopping channels of EUT with FHSS are all operating channels. They are properties of EUT (See annex G).

EUT with AFA or with FHSS shall allow operating channels to be selected manually to facilitate some of the tests to be performed.

Tests on EUT with FHSS shall be carried out with the channel hopping sequence in normal mode and in stop mode. In stop mode, tests shall be carried out on the highest operating channel and the lowest operating channel.

5.2.6 Conducted measurements

5.2.6.1 Artificial antenna

Conducted tests shall be carried out using an artificial antenna (also called a dummy load) which is defined as a 20 dB attenuator connected to the EUT antenna connector and providing a 50 Ω output or connection to test equipment.

The artificial antenna value shall be added to the power measurement values.

NOTE: 20 dB attenuator protects test equipment as the maximum power will never exceed 7 dBm at its input connector.

5.2.7 Radiated measurements

For all radiated measurements a test site, selected from those described in clause D.2, following guidance described in clause D.6, shall be used.

When performing radiated transmitter measurements, the EUT shall be configured and antenna(s) positioned (including smart antenna systems and systems capable of beam forming) and oriented for maximum radiated power into the measuring antenna.

When performing radiated receiver measurements, the EUT shall be configured and antenna(s) positioned (including smart antenna systems and systems capable of beam forming) for maximum sensitivity towards the test antenna. For a transceiver EUT, the most sensitive position is the same position as where the maximum e.r.p. was measured. For receiver only EUT, the measurement test clause 5.5.1.4 shall be performed at different angles from the turntable until the lowest sensitivity level is reached which corresponds to maximum device sensitivity toward the test antenna.

5.2.8 Applicable measurement methods

Although the measurement methods in the present document allow conducted measurements to be performed, the EUT together with all its intended antenna assemblies shall comply with the applicable technical requirements.

Selection of test method is described in clause 5.2.2 conditions.

For equipment with pulse modulation, or where it is not possible to make a required measurement in the absence of modulation, the measurement shall be carried out by the use of a measuring receiver with receiver bandwidth according to clause 5.2.10.

A summary of the applicable measurement methods for each test suite are shown in Table 17.

Table 17: Applicable test methods

Description	Conducted measurements for EUT with connector	Radiated measurements for EUT with dedicated or integral antenna	Test Fixture for EUT with integral antenna for relative measurements (See annex E)
Unwanted emissions in the spurious domain	Yes	Yes	No
Effective radiated power	Yes	Yes	Only for extreme temperature test
Maximum e.r.p spectral density	Yes	Yes	Only for extreme temperature test
Duty cycle	Yes	Yes	Yes
Maximum occupied bandwidth	Yes	Yes	Only for extreme temperature test
Transmitter frequency stability	Yes	Yes	Only for extreme temperature test
Transmitter out of band emissions	Yes	Yes	No
Adjacent channel power	Yes	Yes	No
Transmitter spectrum mask at permitted frequency band edges	Yes	Yes	No
Transient Power	Yes	Yes	No
Behaviour under Low Voltage Conditions	Yes	Yes	Yes
FHSS equipment	Yes	Yes	Yes
Short term behaviour	Yes	Yes	Yes
Receiver sensitivity	Yes	Yes	No
Receiver dynamic range	Yes	Yes	No
Adjacent Channel Selectivity	Yes	Yes	No
Blocking	Yes	Yes	No
Receiver spurious response rejection	Yes	Yes	No
Receiver intermodulation rejection	Yes	Yes	No
CCA threshold	Yes	Yes	No
Polite spectrum access timings parameters	Yes	Yes	Yes

If the EUT has more than one antenna port, e.g. separate antennas for Tx and Rx or separate antennas for different operating frequencies or diversity antennas, then:

- If every antenna port has a 50 Ω connector, conducted measurements may be performed as in Table 17. All the antenna ports shall be terminated in 50 Ω connections as described in clause 5.2.6.1.
- Otherwise only radiated measurements shall be performed.

NOTE: The reason is that replacing one antenna by a transmission line may affect the operation of any other antennas.

5.2.9 Test signals for data

For the purposes of the present document a test signal is a modulated or unmodulated carrier generated by the EUT to facilitate a particular test. The EUT should be capable of generating the following test signals:

- D-M1: A test signal consisting of an unmodulated carrier. This test signal is optional but helps to simplify some tests.
- D-M2: A test signal consisting of a modulated carrier representative of intended use and generating the greatest occupied RF bandwidth. The preferred test signal consists of a pseudo-random bit sequence of at least 511 bits in accordance with Recommendation ITU-T O.153 [i.7]. This sequence shall be continuously repeated.

The EUT shall be capable of generating the following test signal:

- D-M3: A test signal representative of intended use of the EUT. The test signal may be formatted and may contain error detection and correction.

Test signals may be generated by applying baseband signals to a modulation port on test equipment for receivers or be generated internally by equipment for transmitters. Operation in a test mode may involve temporary internal modifications of the equipment under test or the use of special software. Details of the method employed shall be recorded in the test report.

For each test performed, the test signal used shall be recorded in the test report. Test signals for each test are shown in Table 18.

Table 18: Permitted test signals

Clause	Requirement	Test Signal
5.3.1	Unwanted emissions in the spurious domain	D-M1 if available otherwise, D-M2 if available, otherwise D-M3
5.4.1	Effective Radiated Power	D-M1 if available otherwise, D-M2 if available otherwise D-M3
5.4.2	Maximum Effective Radiated Power spectral density	D-M3
5.4.3	Duty Cycle	D-M3
5.4.4	Maximum occupied Bandwidth	D-M2 if available, otherwise D-M3
5.4.5	Transmitter frequency stability	D-M1 if available otherwise, D-M2 if available otherwise D-M3
5.4.6	Transmitter Out Of Band Emissions	D-M2 if available otherwise D-M3
5.4.7	Adjacent Channel Power	D-M2 if available otherwise D-M3
5.4.8	Transmitter spectrum mask at permitted frequency band edge	D-M2 if available otherwise D-M3
5.4.9	Transient power	D-M3
5.4.10	Transmitter behaviour under Low Voltage Conditions	D-M2 if available otherwise D-M3
5.4.11	FHSS equipment	D-M3
5.4.12	Short term behaviour	D-M3
5.5.1	Receiver sensitivity level	D-M3
5.5.2	Receiver dynamic range	D-M3
5.5.3	Adjacent channel selectivity	D-M3
5.5.4	Blocking	D-M3
5.5.5	Receiver spurious response rejection	D-M3
5.5.6	Receiver intermodulation rejection	D-M3
5.6	Polite spectrum access	D-M3

5.2.10 Measuring receiver

5.2.10.1 Description

The term "measuring receiver" refers to a frequency-selective voltmeter or a spectrum analyser. Unless stated otherwise, an RMS detector shall be used.

5.2.10.2 Reference bandwidth

In general, the resolution bandwidth of the measuring receiver (RBW_{measured}) should be equal to the Reference Bandwidth (RBW_{REF}) given in Table 19.

Table 19: Reference bandwidth for the measurement receiver

Frequency range: (f)	Measuring receiver resolution bandwidth (RBW _{REF})
$f < 150 \text{ kHz}$	1 kHz
$150 \text{ kHz} \leq f < 25 \text{ MHz}$	9 kHz or 10 kHz
$25 \text{ MHz} \leq f \leq 1\,000 \text{ MHz}$	100 kHz or 120 kHz
$f > 1\,000 \text{ MHz}$	1 MHz
NOTE: The frequency ranges and corresponding RBW _{REF} values are derived from CISPR 16 [i.8].	

To extract the signal from noise floor, test equipment RBW used for the measurement (RBW_{measured}) may be different from RBW_{REF}.but a correction shall be applied before to compare power levels to limits:

When RBW_{measured} < RBW_{REF} the result should be integrated over RBW_{REF} for instance according to the formula (1):

$$B = 10 \log \left(RBW_{REF} * \frac{\left(\frac{1}{n} \right) * \sum_{i=1}^n \left(10^{\left(\frac{P(i)}{10} \right)} \right)}{RBW_{MEASURED}} \right) \quad (1)$$

Where:

- P(i) are the measured samples with RBW_{measured};
- n is the number of samples inside RBW_{REF};
- B is the corresponding value at RBW_{REF}.

When RBW_{measured} > RBW_{REF} the result for broadband emissions should be normalized to the bandwidth Ratio according to the formula (2):

$$B = A + 10 \log \frac{RBW_{ref}}{RBW_{MEASURED}} \quad (2)$$

Where:

- A is the measured value at the wider measurement bandwidth RBW_{measured};
- B is the corresponding value at RBW_{REF}.

For discrete emissions, defined as a narrow peak with a level of at least 6 dB above the average level inside the measurement bandwidth, the above correction is not applicable while integration over RBW_{REF} is still applicable.

5.3 Conformance methods of measurement for all equipment

5.3.1 Unwanted emissions in the spurious domain

5.3.1.1 Test conditions for Tx mode

For EUT without an external 50 Ω coaxial antenna connector, the spurious emissions levels shall be established by the radiated measurement procedure in clause 5.3.1.3.1.

For all other EUT the spurious emissions levels shall be established as both:

- the conducted measurement procedure in clause 5.3.1.3.2; and

- the radiated measurement procedure in clause 5.3.1.3.1, with the antenna port terminated with a dummy load. (See clause 5.2.6.1).
 - 1) The measurement shall be performed with the EUT operating at its maximum operating power level.
 - 2) The reference RBW of measuring receiver shall be as shown in Table 20.

Table 20: Parameters for Tx Spurious Radiations Measurement

Operating Mode	Frequency Range	RBW _{REF} (see note 2)
Transmit mode	$9 \text{ kHz} \leq f < 150 \text{ kHz}$	1 kHz
	$150 \text{ kHz} \leq f < 30 \text{ MHz}$	10 kHz
	$30 \text{ MHz} \leq f < f_{\text{nom}} - m$	100 kHz
	$f_{\text{nom}} - m \leq f < f_{\text{nom}} - n$	10 kHz
	$f_{\text{nom}} - n \leq f < f_{\text{nom}} - p$	1 kHz
	$f_{\text{nom}} + p < f \leq f_{\text{nom}} + n$	1 kHz
	$f_{\text{nom}} + n < f \leq f_{\text{nom}} + m$	10 kHz
	$f_{\text{nom}} + m < f \leq 1 \text{ GHz}$	100 kHz
	$1 \text{ GHz} < f \leq 6 \text{ GHz}$	1 MHz
NOTE 1: f is the measurement frequency. f_{nom} is the nominal operating frequency. m is 10 x OCW or 500 kHz, whichever is the greater. n is 4 x OCW or 100 kHz, whichever is the greater. p is 2,5 x OCW. NOTE 2: If the value of RBW used for measurement is different from RBW _{REF} bandwidth correction from clause 5.2.10 shall be used.		

The frequency range from $f_{\text{nom}} - 2,5 \times \text{OCW}$ to $f_{\text{nom}} + 2,5 \times \text{OCW}$ which is not part of transmitter spurious domain shall be excluded from the measurements to avoid spectrum analyser's front end overload.

5.3.1.2 Test conditions for Rx and all other modes

For EUT without an external 50 Ω coaxial antenna connector, the spurious emissions levels shall be established by the radiated measurement procedure in clause 5.3.1.3.1.

For all other EUT the spurious emissions levels shall be established as both:

- the conducted measurement procedure in clause 5.3.1.3.2; and
- the radiated measurement procedure in clause 5.3.1.3.1, with the antenna port terminated with a dummy load.

5.3.1.3 Measurement procedure

5.3.1.3.1 Radiated measurement

5.3.1.3.1.0 General

Test site is selected according to clause D.6.

The EUT shall be connected to its normal operating antenna.

The output of the test antenna shall be connected to a measuring receiver. The measurements described shall be performed using radiated measurement methods described in clause D.5.1 (or clause D.5.2) depending on the test site, followed by clause D.5.3. The operation of the EUT shall be started.

For Tx mode clause 5.3.1.1 applies.

The measuring receiver shall be tuned over the frequency range shown in Table 21.

Table 21: Spurious radiations radiated measurement frequency range

Frequency Range
25 MHz to 6 GHz

5.3.1.3.1.1 Pre-scan

This pre-scan test procedure shall be used to identify possible unwanted emissions of the EUT.

Step 1:

The sensitivity of the spectrum analyser should be such that the noise floor is at least 12 dB below the limits given in Table 3.

Table 22: Parameters for radiated pre-scan over the range 25 MHz to 1 000 MHz

Spectrum Analyser Setting	Value
RBW	10 kHz for $25 \text{ MHz} \leq f < 30 \text{ MHz}$ 100 kHz for $f \geq 30 \text{ MHz}$
VBW	3 x RBW
Detector Mode	Peak
Trace Mode	Max hold
Sweep points	$\geq 2\,000$ for $25 \text{ MHz} \leq f < 30 \text{ MHz}$ $\geq 20\,000$ for $f \geq 30 \text{ MHz}$ For spectrum analysers not supporting this number of sweep points, the frequency band may be segmented. For spectrum analysers capable of supporting twice this number of sweep points, the frequency adjustment in clause 5.3.1.3.3 (step 1, last bullet) may be omitted.
Sweep time	For DM-3 test signal, the sweep time shall be such that for each 10 kHz/100 kHz frequency step respectively, the measurement time is greater than two transmissions of the EUT.

The test equipment shall be configured for the parameters shown in Table 22.

The unwanted emissions over the range 25 MHz to 1 000 MHz shall be identified.

Allow the trace to stabilize. Any emissions identified that have a margin of less than 6 dB below the limits given in clause 4.3.1.2 shall be individually measured using the procedure in clause 5.3.1.3.3 according to clause D.5 and compared to the limits given in clause 4.3.1.2.

The maximum signal level detected by the measuring receiver for vertical and horizontal polarization shall be noted.

The radiated measurements in clause D.5.1 (or clause D.5.2) followed by the substitution measurement defined in clause D.5.3 shall be performed with the frequency of the calibrated signal generator set to the frequency of the spurious component detected and, if necessary, the input attenuator setting of the measuring receiver adjusted in order to increase the sensitivity of the measuring receiver.

The measure of the effective radiated power of the spurious component is the larger of the two power levels at the input to the substitution antenna increased by the substitution antenna gain corrected by the cable loss (values in dB).

Step 2:

Table 23: Parameters for radiated pre-scan over the range 1 GHz to 6 GHz

Spectrum Analyser Setting	Value
RBW	1 MHz
VBW	3 MHz
Detector Mode	Peak
Trace Mode	Max hold

Spectrum Analyser Setting	Value
Sweep points	<p>≥ 25 000</p> <p>For spectrum analysers not supporting this number of sweep points, the frequency band may be segmented. For spectrum analysers capable of supporting twice this number of sweep points, the frequency adjustment in clause 5.3.1.3.3. (step 1, last bullet) may be omitted.</p>
Sweep time	For DM-3 test signal, the sweep time shall be such that for each 1 MHz frequency step, the measurement time is greater than two transmissions of the EUT.

The test equipment shall be configured for the parameters shown in Table 23.

The unwanted emissions over the range 1 GHz to 6 GHz shall be identified

Allow the trace to stabilize. Any emissions identified that have a margin of less than 6 dB below the limits given in clause 4.3.1.2 shall be individually measured using the procedure in clause 5.3.1.3.3 according to clause D.5 and compared to the limits given in clause 4.3.1.2.

The maximum signal level detected by the measuring receiver for vertical and horizontal polarization shall be noted.

The radiated measurements in clause D.5.1 (or clause D.5.2) followed by the substitution measurement defined in clause D.5.3 shall be performed with the frequency of the calibrated signal generator set to the frequency of the spurious component detected and, if necessary, the input attenuator setting of the measuring receiver adjusted in order to increase the sensitivity of the measuring receiver.

The measure of the effective radiated power of the spurious component is the larger of the two power levels at the input to the substitution antenna increased by the substitution antenna gain corrected by the cable loss (values in dB).

5.3.1.3.2 Conducted measurement

5.3.1.3.2.0 General

The antenna port of the EUT shall be connected to the dummy load and the output of the dummy load connected to the measuring receiver.

The operation of the EUT shall be started.

For Tx mode clause 5.3.1.1 applies.

The measuring receiver shall be tuned over the frequency range shown in Table 24.

Table 24: Spurious Radiations conducted Measurement Frequency Range

Frequency Range
9 kHz to 6 GHz

5.3.1.3.2.1 Pre-scan

This pre-scan test procedure shall be used to identify possible unwanted emissions of the EUT.

Step 1:

The sensitivity of the spectrum analyser should be such that the noise floor is at least 12 dB below the limits given in Table 3.

Table 25: Parameters for conducted pre-scan over the range 9 kHz to 1 000 MHz

Spectrum Analyser Setting	Value
RBW	1 kHz for $9 \text{ kHz} \leq f < 150 \text{ kHz}$ 10 kHz for $150 \text{ kHz} \leq f < 30 \text{ MHz}$ 100 kHz for $f \geq 30 \text{ MHz}$
VBW	3 x RBW
Detector Mode	Peak
Trace Mode	Max hold
Sweep points	≥ 300 for $9 \text{ kHz} \leq f < 150 \text{ kHz}$ $\geq 2\,000$ for $25 \text{ MHz} \leq f < 30 \text{ MHz}$ $\geq 20\,000$ for $f \geq 30 \text{ MHz}$ For spectrum analysers not supporting this number of sweep points, the frequency band may be segmented. For spectrum analysers capable of supporting twice this number of sweep points, the frequency adjustment in clause 5.3.1.3.3 (step 1, last bullet) may be omitted.
Sweep time	For DM-3 test signal, the sweep time shall such that for each 1 kHz/10 kHz/100 kHz frequency step respectively, the measurement time is greater than two transmissions of the EUT.

The test equipment shall be configured for the parameters shown in Table 25.

The unwanted emissions over the range 9 kHz to 1 000 MHz shall be identified.

Allow the trace to stabilize. Any emissions identified that have a margin of less than 6 dB with respect to the limits given in clause 4.3.1.2 shall be individually measured using the procedure in clause 5.3.1.3.3 and compared to the limits given in clause 4.3.1.2.

Step 2:

Table 26: Parameters for conducted pre-scan over the range 1 GHz to 6 GHz

Spectrum Analyser Setting	Value
RBW	1 MHz
VBW	3 MHz
Detector Mode	Peak
Trace Mode	Max hold
Sweep points	$\geq 25\,000$ For spectrum analysers not supporting this number of sweep points, the frequency band may be segmented. For spectrum analysers capable of supporting twice this number of sweep points, the frequency adjustment in clause 5.3.1.3.3 (step 1, last bullet) may be omitted.
Sweep time	For DM-3 test signal, the sweep time shall such that for each 1 MHz frequency step, the measurement time is greater than two transmissions of the EUT.

The test equipment shall be configured for the parameters shown in Table 26.

The unwanted emissions over the range 1 GHz to 6 GHz shall be identified.

Allow the trace to stabilize. Any emissions identified that have a margin of less than 6 dB with respect to the limits given in clause 4.3.1.2 shall be individually measured using the procedure in clause 5.3.1.3.3 and compared to the limits given in clause 4.3.1.2.

5.3.1.3.3 Measurement of emissions identified during the pre-scan

The steps below shall be used to accurately measure the individual mean power of unwanted emissions identified during the pre-scan measurements above.

For continuous transmit signals, a simple measurement of mean power using the RMS detector of the spectrum analyser is permitted.

For DM-3 test signals, the measurement shall be made only over the "on" part of the burst.

Step 1:

Table 27: Parameters for emissions identified by pre-scan

Spectrum Analyser Setting	Value
Centre Frequency	Frequency of emission identified during pre-scan
RBW	1 kHz for $9 \text{ kHz} \leq f < 150 \text{ kHz}$ 10 kHz for $150 \text{ kHz} \leq f < 30 \text{ MHz}$ 100 kHz for $30 \text{ MHz} \leq f < 1 \text{ GHz}$ 1 MHz for $1 \text{ GHz} \leq f \leq 6 \text{ GHz}$
VBW	3 x RBW
Frequency span	Zero span
Sweep mode	Single sweep
Sweep time	Suitable to capture one transmission burst. Additional measurements may be needed to identify the length of the transmission burst. In case of continuous signals, the Sweep Time shall be set to 30 ms
Sweep points	Sweep time [μs]/1 μs with a maximum of 30 000
Trigger mode	Video (burst signal) or Manual (continuous signal)
Detector Mode	RMS
Trace Mode	Clear/Write

The level of the emissions shall be displayed in the zero span mode, using the spectrum analyser settings shown in Table 27.

Adjust the centre frequency (fine tune) to capture the highest level of one burst of the emission to be measured. This fine tuning can be omitted for spectrum analysers capable of supporting twice this number of sweep points required in step 2 from the pre-scan procedure in clause 5.3.1.3.1.1 for conducted measurement and clause 5.3.1.3.2.1 for radiated measurement.

Step 2:

Adjust the trigger level to select the transmissions with the highest power level.

Set a window (start and stop lines) to match with the start and end of the burst and in which the RMS power shall be measured using the Power function. If the spurious emission to be measured is a continuous signal, the measurement window shall be set to match the start and stop times of the sweep.

Select RMS power to be measured within the selected window and note the result which is the RMS power of this particular spurious emission. Compare this value with the applicable limit provided by clause 4.3.1.2.

Repeat this procedure for every emission identified during the pre-scan. The values and corresponding frequencies shall be recorded as shown in Table 28.

Table 28: Information recorded in the test report for unwanted emissions

Parameter	Value Recorded in the Test Report
Emission Frequency	The frequency of the emission
Emission Power	The rms power value displayed by the spectrum analyser

5.4 Conformance methods of measurement for transmitters

5.4.1 Effective radiated power

5.4.1.1 Effective radiated power (radiated measurement)

5.4.1.1.1 General

This measurement method applies to EUT other than those measured using clause 5.4.1.2.

5.4.1.1.2 Test conditions

- 1) The measurement shall be performed on the EUT set to the nominal operating frequency. These measurements shall be performed at the highest power level at which EUT is intended to operate.
- 2) The EUT shall be switched on without modulation, if D-M1 is available, and the measuring receiver shall be tuned to the nominal operating frequency of EUT. D-M1 test signal (unmodulated carrier) shall not be used for equipment with non-constant envelope modulation.
- 3) Span of the spectrum analyser shall be the Permitted Frequency Band.
- 4) The RBW of the spectrum analyser shall be wide enough to cover the complete power envelope (\geq OCW) of the signal of the EUT. VBW shall be the nearest setting to 3 x RBW.
- 5) In the case of a removable antenna, the antenna shall be fitted in a manner representative of intended use.

5.4.1.1.3 Measurement procedure

A test site is selected according to clause D.6 and the radiated power established using the procedures described in clause D.5.1 (or clause D.5.2) depending on the test site, followed by clause D.5.3.

The information shown in Table 29 shall be recorded in the test report.

Table 29: Information recorded in the test report for Effective Radiated Power

Value	Notes
Test environment	Modulated or unmodulated carrier
EUT frequency	EUT nominal operating frequency
Measure of Effective Radiated Power	Larger value from horizontal and vertical polarization measurement effective radiated power

5.4.1.2 Effective Radiated Power (conducted measurement)

5.4.1.2.1 General

This method applies only to EUT with a permanent external antenna connector.

5.4.1.2.2 Test conditions

- 1) The measurement shall be performed on the EUT set to the nominal operating frequency.
- 2) EUT shall be switched on without modulation, if D-M1 is available, and the measuring receiver shall be tuned to the nominal operating frequency of EUT. D-M1 test signal (unmodulated carrier) shall not be used for EUT with non-constant envelope modulation.
- 3) Span of the spectrum analyser shall be the Permitted Frequency Band.
- 4) The RBW of the spectrum analyser shall be wide enough to cover the complete power envelope (\geq OCW) of the signal of the EUT. VBW shall be the nearest setting to 3 x RBW.

5.4.1.2.3 Measurement procedure

The antenna port of the EUT shall be connected to a 20 dB attenuator and the output of the attenuator connected to the measuring receiver.

The information shown in Table 30 shall be recorded in the test report.

Table 30: Information recorded in the test report for conducted Effective Radiated Power

Value	Notes
Test environment	Modulated or unmodulated carrier
EUT frequency	EUT nominal operating frequency
Measured power (Conducted)	Maximum measured conducted power value
NOTE:	The maximum permitted gain relative to a half wave dipole for any antenna used with the EUT is the ERP limit specified in Table 2 or NRI minus the measured conducted output power.

5.4.2 Maximum e.r.p. power spectral density

5.4.2.1 Test conditions

- 1) The measurement shall be performed on the EUT set to the nominal operating frequency. If the EUT is designed to operate with different power levels, these measurements shall be performed at the highest power level at which EUT is intended to operate.
- 2) EUT shall be switched on with modulation using test signal from clause 5.2.9, Table 18 and the measuring receiver shall be tuned to the frequency of EUT.
- 3) An EUT without a permanent antenna connector shall be tested according to clause 5.4.2.2.
- 4) An EUT with a permanent antenna connector shall be tested according to clause 5.4.2.3.

5.4.2.2 Radiated measurement

A test site is selected according to clause D.6 and the measurements in clause 5.4.2.4 shall be performed using corresponding radiated measurement methods described in clause D.5.

5.4.2.3 Conducted measurement

EUT is connected to the spectrum analyser with the artificial antenna.

The measurements in clause 5.4.2.4 shall be performed.

5.4.2.4 Measurement procedure

Connect the EUT to the spectrum analyser and use Table 31 settings:

Table 31: Test Parameters for power spectral density

Spectrum Analyser Setting	Value	Notes
EUT frequency	f_{nom}	Nominal operating frequency
Span	\geq OBW	To cover the complete power envelope of the signal of EUT
RBW	100 kHz	In the case that the regulatory parameter is expressed in dBm/10 kHz, RBW shall be set to 10 kHz.
VBW	100 kHz	In the case that the regulatory parameter is expressed in dBm/10 kHz, VBW shall be set to 10 kHz.
Sweep time	1 minute	
Detector Function	RMS	
Trace Mode	Max Hold	

When the trace is complete, capture the trace, for example using the "View" option on the spectrum analyser.

Find the peak value of the trace and place the analyser marker on this peak. This level is recorded as the highest mean power (spectral power density) D in a 100 kHz band.

Alternatively, where a spectrum analyser is equipped with a facility to measure spectral power density, this facility may be used to display the spectral power density D in dBm/100 kHz.

The maximum e.r.p. spectral density is calculated from the above measured power density (D) and the applicable antenna assembly gain " G " in dB relative to an ideal half wave dipole, according to the formula (3). If more than one antenna assembly is intended for this power setting, the gain of the antenna assembly with the highest gain shall be used.

$$PD = D + G \quad (3)$$

The information shown in Table 32 shall be recorded in the test report.

Table 32: Information recorded in the test report for maximum e.r.p. power spectral density

Value	Notes
EUT frequency	EUT nominal operating frequency
Maximum radiated Power density	Maximum measured radiated power density

5.4.3 Duty cycle

5.4.3.1 Test conditions

Assessment of the overall Duty Cycle shall be made for a representative period of T_{obs} over the observation bandwidth F_{obs} . Unless otherwise specified, T_{obs} is 1 hour and the observation bandwidth F_{obs} is the permitted frequency band.

The EUT shall be configured to transmit in a manner representative of normal operation for its intended use. As a guide "normal use" is considered as representing the behaviour of the device during transmission of 99 % of transmissions generated during its operational lifetime.

Procedures such as setup, commissioning and maintenance are not considered part of normal operation.

Where an acknowledgement is used, the additional transmitter on-time from a message responder shall be taken into account only once whether included in the message initiator Duty Cycle or in the message responder Duty Cycle.

NOTE: The intention of this rule is not to allow EUT to exceed the maximum duty cycle value.

- 1) An EUT without a permanent or temporary antenna connector shall be tested according to clause 5.4.3.2.
- 2) An EUT with a permanent or temporary antenna connector shall be tested according to clause 5.4.3.3.

5.4.3.2 Radiated measurement

A test site is selected according to clause D.6.

The measurements in clause 5.4.3.4 shall be performed.

5.4.3.3 Conducted measurement

The transmitter output of the EUT shall be connected to power sensing equipment. The measurements in clause 5.4.3.4 shall be performed.

5.4.3.4 Measurement procedure

The power sensing equipment shall be configured for the parameters specified in Table 33.

Table 33: Power Sensing settings for duty cycle measurement

Setting	Value	Notes
Sample rate	≥ 1 M samples/second	Sampling rate for at least 1 μ second resolution
Bandwidth	PFB	Permitted frequency band
Trigger		Trigger setting to capture leading edge of first transmission
$P_{\text{threshold}}$	-26 dBc	Signal threshold

The EUT signal shall be measured with a power sensor and its levels adjusted according to the power envelope of the EUT transmissions.

It is recommended to use a Real Time Spectrum Analyser for T_{obs} around 1 second and a Digital Signal Oscilloscope for measurements over other T_{obs} values. If DSO memory size cannot store 1 hour of measurement, it is allowed to perform successive measurements of several minutes until reaching 1 hour.

Step 1:

The EUT shall be set to operate with a test signal representative of normal operation of the EUT for its intended use. The power sensing equipment shall be used to sample power in the observation bandwidth for the observation period.

The sampled power readings shall be saved.

Step 2:

Using an analysis software the start time and stop time of each sequence of samples above $P_{\text{threshold}}$ during T_{obs} shall be obtained.

Between the saved start and stop times of each individual burst, the T_{on} time shall be calculated. These T_{on} values shall be saved.

Duty cycle is the sum of the T_{on} times divided by the observation period T_{obs} . Duty cycle value shall be recorded.

5.4.4 Maximum occupied bandwidth**5.4.4.1 Test conditions**

- 1) The measurement shall be performed with a spectrum analyser.
- 2) An EUT without a permanent or temporary antenna connector shall be tested according to clause 5.4.4.2.
- 3) An EUT with a permanent or temporary antenna connector shall be tested according to clause 5.4.4.3.

5.4.4.2 Radiated measurement

A test site is selected according to clause D.6 and the measurements in clause 5.4.4.4 shall be performed using corresponding radiated measurement methods described in clause D.5.

5.4.4.3 Conducted measurement

EUT is connected to the spectrum analyser with the artificial antenna.

The measurements in clause 5.4.4.4 shall be performed.

5.4.4.4 Measurement procedure

The spectrum analyser shall be configured for the parameters shown in Table 34.

Table 34: Test parameters for occupied bandwidth measurement

Setting	Value	Notes
EUT frequency	Nominal operating frequency	

Setting	Value	Notes
RBW	1 % to 3 % of OCW without being below 100 Hz	
VBW	3 x RBW	Smallest available analyser setting greater than or equal to 3 x RBW
Span	At least 2 x OCW	Span should be large enough to include all major components of the signal and its side bands
Detector Mode	RMS	
Trace	Max hold	

Step 1:

Operation of the EUT shall be started on the EUT nominal operating frequency with test signal selected in accordance with clause 5.2.9.

The signal attenuation shall be adjusted to ensure that the -23 dBc-points are at least 10 dB above the noise floor of the spectrum analyser to avoid the noise signals on either side of the power envelope being included in the measurement.

Step 2:

When the trace is completed the peak value of the trace shall be located and the analyser marker placed on this peak.

Step 3:

The 99 % occupied bandwidth function of the spectrum analyser shall be used to measure the occupied bandwidth of the signal. Occupied bandwidth frequency edges $FOBW_{low}$ and $FOBW_{high}$ shall be measured.

If the spectrum analyser does not have a 99 % OBW function, recover the trace data points and sum directly in linear power terms. Place the recovered amplitude data points starting from the lowest frequency, in a running sum until 0,5 % of the total is reached. Record that frequency as the lower OBW frequency. Repeat the process until 99,5 % of the total is reached and record that frequency as the upper OBW frequency. The 99 % power OBW is then determined by computing the difference between these two frequencies. The OBW shall be reported and plot(s) of the spectrum analyser display shall be provided with the test report. The frequency and amplitude axis and scale shall be clearly labelled. Tabular data can be reported in addition to the plot(s).

The information shown in Table 35 shall be recorded for each nominal operating frequency and over the full environmental profile.

Table 35: Information recorded in the test report for Occupied Bandwidth

Value	Notes
EUT frequency	Nominal operating frequency tested
Instantaneous occupied bandwidth value (OBW)	The value measured with the spectrum analyser
Lower frequency edge ($FOBW_{low}$)	The value measured with the spectrum analyser
Upper frequency edge ($FOBW_{high}$)	The value measured with the spectrum analyser
Highest measured occupied bandwidth value (OBW_{high})	Highest measured OBW value over the full environmental profile

5.4.5 Transmitter frequency stability

5.4.5.1 Test condition

- 1) The measurement shall be performed on the EUT set to the nominal operating frequency.
- 2) An EUT without a permanent or temporary antenna connector shall be tested according to clause 5.4.5.2.
- 3) An EUT with a permanent or temporary antenna connector shall be tested according to clause 5.4.5.3.
- 4) If D-M1 test signal is available (unmodulated carrier), measurement shall be performed according to clause 5.4.5.4.
- 5) For all other test signals from clause 5.2.9 Table 18, measurement shall be performed according to clause 5.4.5.5.

5.4.5.2 Radiated measurement

A test site is selected according to clause D.6. If D-M1 test signal is available, the measurements in clause 5.4.5.4 shall be performed using corresponding radiated measurement methods described in clause D.5. If D-M1 test signal is not available, the measurement in clause 5.4.5.5 shall be performed using corresponding radiated measurement methods described in clause D.5.

5.4.5.3 Conducted measurement

The EUT shall be connected to the spectrum analyser. If D-M1 test signal is available, the measurements in clause 5.4.5.4 shall be performed. If D-M1 test signal is not available, the measurement in clause 5.4.5.5 shall be performed.

5.4.5.4 Measurement procedure for D-M1 test signal

- 1) The measurement shall be performed with an unmodulated carrier test signal (D-M1) for steps 1 to 2.

Step 1:

Operation of the EUT shall be started on the normal test conditions.

The frequency of the unmodulated carrier (N) shall be measured and noted.

Step 2:

Operation of the EUT shall be started on the nominal operating frequency.

The temperature and voltage shall be changed from the lowest to the highest values respectively as given in the environmental profile.

The lowest frequency of the unmodulated carrier (A) shall be measured according to the conditions given in clause 5.2.4 and noted.

The highest frequency of the unmodulated carrier (B) shall be measured according to the conditions given in clause 5.2.4 and noted.

Step 3:

Occupied bandwidth frequency edges $FOBW_{low}$ and $FOBW_{high}$ are measured at normal test conditions according to clause 5.4.4 with D-M2 test signal if available, D-M3 otherwise.

The information shown in Table 36 shall be recorded for each operating channel.

Table 36: Information recorded in the test report for transmitter frequency stability

Value	Notes
Test signal	The test signal used. See Table 18
EUT frequency	Nominal operating frequency
Measured carrier frequency (N)	Measured unmodulated carrier frequency at normal test conditions
Carrier frequency (A) under lower test conditions from environmental profile	Measured unmodulated carrier frequency
Carrier frequency (B) under higher test conditions from environmental profile	Measured unmodulated carrier frequency
Frequency error (lower & upper)	A-N and B-N
FOC_{low}	Lower operating channel edge
FOC_{high}	Upper operating channel edge
Min $FOBW_{low}$	Min $FOBW_{low} = FOC_{low} - (A-N)$
Max $FOBW_{high}$	Max $FOBW_{high} = FOC_{high} + (B-N)$

5.4.5.5 Measurement procedure for other test signal

- 1) The measurement shall be performed with modulated carrier test signal according to clause 5.2.9, Table 18.

Step 1:

Operation of the EUT shall be started on the nominal operating frequency.

Step 2:

OBW frequency edges $FOBW_{low}$ and $FOBW_{high}$ are measured according to clause 5.4.4 over the full range of temperature and voltage conditions from the environmental profile.

Min $FOBW_{low}$ is the smallest lower frequency edge of OBW measured over environmental profile.

Max $FOBW_{high}$ is the highest upper frequency edge of OBW measured over environmental profile.

The information shown in Table 37 shall be recorded for each operating channel.

Table 37: Information recorded in the test report for transmitter frequency stability

Value	Notes
Test signal	The test signal used. See Table 18
EUT frequency	Nominal operating frequency tested
FOC_{low}	Lower operating channel edge
FOC_{high}	Upper operating channel edge
Min $FOBW_{low}$	Smallest measured lower frequency edge of OBW over full environmental profile
Max $FOBW_{high}$	Highest measured upper frequency edge of OBW over full environmental profile

5.4.6 Transmitter out of band emissions

5.4.6.1 Test conditions

- 1) An EUT without a permanent or temporary antenna connector shall be tested according to clause 5.4.6.2.
- 2) An EUT with a permanent or temporary antenna connector shall be tested according to clause 5.4.6.3.

5.4.6.2 Radiated measurement

The measurements shall be performed using the procedure in clause 5.4.6.4 using a test site selected according to clause D.6 and using corresponding radiated measurement methods described in clause D.5.1 (or clause D.5.2) depending on the test site, followed by clause D.5.3.

5.4.6.3 Conducted measurement

The EUT shall be connected to an artificial antenna which shall be connected to the test equipment. An attenuator shall be selected in order that maximum RF power limit of the analyser is not exceeded.

The measurements in clause 5.4.6.4 shall be performed.

5.4.6.4 Measurement procedure

The test equipment shall be configured with parameters shown in Table 38.

Table 38: Test Parameters for out of band emissions

Spectrum Analyser Setting	Value	Notes
EUT frequency	f_{nom}	Nominal operating frequency
Span	6 x OCW	
RBW	1 kHz (see note)	Resolution bandwidth for Out Of Band domain measurements
Detector Function	RMS	
Trace Mode	Linear AVG	Applies only for EUT generating D-M2 test signal
	Max Hold	Applies only for EUT generating D-M3 test signal
NOTE: If the value of RBW used is different from RBW_{REF} in clause 4.4.6, use the bandwidth correction described in clause 5.2.10.2.		

Step 1:

Operation of the EUT shall be started, on the nominal operating frequency and set to max output power level with test signal selected from clause 5.2.9, Table 18.

The signal shape is recorded when stable and shall be below the spectrum mask transmitter Out Of Band emissions defined in clause 4.4.6.3.

5.4.7 Adjacent channel power**5.4.7.1 Test conditions**

- 1) The measurement shall be performed at the EUT nominal operating frequency. These measurements shall be performed at the highest power level at which EUT is intended to operate.
- 2) For EUT using frequency agile, FHSS or frequency hopping feature, the test conditions in clause 5.2.5 apply.
- 3) An EUT without a permanent or temporary antenna connector shall be tested according to clause 5.4.7.2.
- 4) An EUT with a permanent or temporary antenna connector shall be tested according to clause 5.4.7.3.

5.4.7.2 Radiated measurement

A test site is selected according to clause D.6 and the measurements in clause 5.4.7.4 performed using corresponding radiated measurement methods described in clause D.5.

The measurements in clause 5.4.7.4 shall be performed.

5.4.7.3 Conducted measurement

The EUT shall be connected to an artificial antenna which shall be connect to the test equipment via an attenuator. An attenuator shall be selected in order that the maximum RF power limit of the analyser is not exceeded.

The measurements in clause 5.4.7.4 shall be performed.

5.4.7.4 Measurement procedure

The spectrum analyser shall be configured with parameters shown in Table 39.

Table 39: Test Parameters for Adjacent Channel Power

Setting	Value	Notes
EUT frequency	f_{nom}	The nominal Operating Frequency
RBW	100 Hz	
VBW	$\geq 3 \times \text{RBW}$	
Span	At least 5 x Operating Channel width	Span should be large enough to include Adjacent and Alternate Adjacent Channel
Detector Mode	RMS	
Trace mode	Max Hold	

Step 1:

Operation of the EUT shall be started, on nominal operating frequency. The modulation used shall be set according to Table 18.

The signal attenuation shall be adjusted to ensure that the signal power is not saturating the Spectrum analyser input port.

Step 2:

When the trace is completed, the integrated power over a bandwidth of RBW_{REF} centred on an offset from centre frequency as specified in Table 40. The spectrum analyser's ACP function or an integrating marker may be used. If the spectrum analyser's ACP function is used any additional filtering over the integration bandwidth shall be disabled.

Table 40: Offset and RBW_{REF} parameters

Measurement	Offset from OC centre frequency	RBW_{REF}
Adjacent channel	$\pm \text{OCW}$	$0,7 \times \text{OCW}$
Alternate channel	$\pm 2 \times \text{OCW}$	$0,7 \times \text{OCW}$

The information shown in Table 41 shall be recorded.

Table 41: Information recorded in the test report for Adjacent channel power

Value	Notes
EUT frequency	Nominal operating frequency tested
Adjacent channel power	The value measured with the spectrum analyser
Alternate adjacent channel power	The value measured with the spectrum analyser

5.4.8 Transmitter spectrum mask at permitted frequency band edges

5.4.8.1 Test conditions

- 1) An EUT without a permanent or temporary antenna connector shall be tested according to clause 5.4.8.2.
- 2) An EUT with a permanent or temporary antenna connector shall be tested according to clause 5.4.8.3.

5.4.8.2 Radiated measurement

The measurements shall be performed using the procedure in clause 5.4.8.4 using a test site selected according to clause D.6 and using corresponding radiated measurement methods described in clause D.5.1 (or clause D.5.2) depending on the test site, followed by clause D.5.3.

5.4.8.3 Conducted measurement

The EUT shall be connected to an artificial antenna which shall be connect to the test equipment. An attenuator shall be selected in order that maximum RF power limit of the analyser is not exceeded.

The measurement in clause 5.4.8.4 shall be performed.

5.4.8.4 Measurement procedure

The test equipment shall be configured with parameters shown in Table 42.

Table 42: Test parameters for transmitter spectrum mask at permitted frequency band edges

Spectrum Analyser Setting	Value	Notes
EUT frequency	f_{nom}	Nominal operating frequency
Span	$FB_{low} - 450 \text{ kHz}$ to $FB_{high} + 450 \text{ kHz}$	
RBW	1 kHz (see note)	Resolution bandwidth for Out Of Band domain measurements
Detector Function	RMS	
Trace Mode	Linear AVG	Applies only for EUT generating D-M2 test signal
	Max Hold	Applies only for EUT generating D-M3 test signal
NOTE: If the value of RBW used is different from RBW_{REF} in clause 4.4.8, use the bandwidth correction described in clause 5.2.10.2.		

Step 1:

Operation of the EUT shall be started, on the nominal operating frequency with test signal selected from Table 18.

The signal is recorded when stable.

Step 2:

- 1) For EUT using several Permitted Frequency Bands, the measurement shall be repeated in each Permitted Frequency Band.

5.4.9 Transient power

5.4.9.1 Test conditions

- 1) The measurement shall be performed on the EUT nominal operating frequency. These measurements shall be performed at the highest power level at which EUT is intended to operate.
- 2) An EUT without a permanent connector shall be tested according to clause 5.4.9.2.
- 3) An EUT with a permanent connector shall be tested according to clause 5.4.9.3.

5.4.9.2 Radiated measurement

The measurements shall be performed using the procedure in clause 5.4.9.4 using a test site selected according to clause D.6 and using corresponding radiated measurement methods described in clause D.5.1 (or clause D.5.2) depending on the test site, followed by clause D.5.3.

- 1) The measurements in clause 5.4.9.4 shall be performed.

5.4.9.3 Conducted measurement

The EUT shall be connected to an artificial antenna which shall be connected to the test equipment.

- 1) The measurements in clause 5.4.9.4 shall be performed.

5.4.9.4 Measurement procedure

The output of the EUT shall be connected to a spectrum analyser.

The measurement shall be undertaken in **zero span** mode. The analyser's centre frequency shall be set to an offset from the nominal operating frequency. These offset values and their corresponding RBW configurations are listed in Table 43.

Table 43: RBW for transient measurement

Measurement points: offset from OC centre frequency	Analyser RBW	RBW _{REF}
-0,5 x OCW - 3 kHz 0,5 x OCW + 3 kHz Not applicable for OCW < 25 kHz	1 kHz	1 kHz
±12,5 kHz or ±OCW whichever is the greater	Max (RBW pattern 1, 3, 10 kHz) ≤ Offset frequency/6 (see note)	1 kHz
-0,5 x OCW - 400 kHz 0,5 x OCW + 400 kHz	100 kHz	1 kHz
-0,5 x OCW - 1 200 kHz 0,5 x OCW + 1 200 kHz	300 kHz	1 kHz
NOTE: Max (RBW pattern 1, 3, 10 kHz) means the maximum bandwidth that falls into the commonly implemented 1, 3, 10 kHz RBW filter bandwidth incremental pattern of spectrum analysers. EXAMPLE: If OCW is 25 kHz then the RBW value corresponding to one OCW offset frequency is 3 kHz. The rest of the analyser settings are listed in Table 44, and if OCW is 250 kHz then the RBW value corresponding to one OCW offset frequency is 30 kHz.		

Table 44: Parameters for transient measurement

Spectrum Analyser Setting	Value	Notes
VBW/RBW	10	At higher RBW values VBW may be clipped to its maximum value
Sweep time	500 ms	
RBW filter	Gaussian	
Trace Detector Function	RMS	
Trace Mode	Max hold	
Sweep points	501	
Measurement mode	Continuous sweep	
NOTE: The ratio between the number of sweep points and the sweep time shall be the same ratio as above if different number of sweep points is used.		

The used modulation shall be D-M3. The analyser shall be set to the settings of Table 44 and a measurement shall be started for each offset frequency. The EUT shall transmit at least five D-M3 test signal. The peak value shall be recorded and the measurement shall be repeated at each offset frequency listed in Table 43.

The recorded power values shall be converted to power values measured in RBW_{REF} by the formula in clause 5.2.10.2.

5.4.10 Transmitter behaviour under low voltage conditions

5.4.10.1 Test conditions

- 1) An EUT without a permanent or temporary antenna connector shall be tested according to clause 5.4.10.2.
- 2) An EUT with a permanent or temporary antenna connector shall be tested according to clause 5.4.10.3.

5.4.10.2 Radiated measurement

The measurements shall be performed using the procedure in clause 5.4.10.4 using a test site selected according to clause D.6 and using corresponding radiated measurement methods described in clause D.5.1 (or clause D.5.2) depending on the test site, followed by clause D.5.3.

5.4.10.3 Conducted measurement

The EUT shall be connected to an artificial antenna which shall be connected to the test equipment.

- 1) The measurements in clause 5.4.10.4 shall be performed.

5.4.10.4 Measurement procedure

The spectrum analyser shall be configured with parameters shown in Table 45.

Table 45: Test Parameters for Tx behaviour at low voltage

Setting	Value	Notes
EUT frequency	f_{nom}	The nominal Operating Frequency
RBW	1 % to 3 % of OCW without being below 100 Hz	
VBW	$\geq 3 \times RBW$	Smallest available analyser setting greater than or equal to $3 \times RBW$
Span	$3 \times PFB$	Span should be large enough to include Permitted Frequency Band and adjacent bands
Detector Mode	RMS	
Trace mode	Max hold	

Step 1:

Operation of the EUT shall be started, on the nominal operating frequency with test signal as given in Table 18 and with the EUT operating at nominal operating voltage.

The transmitted signal trace shall be measured and noted.

Step 2:

The operating voltage shall be reduced by 10 % steps of nominal voltage until the voltage reaches zero.

The signal frequency and power level of the transmitted signal at peak power shall be measured and noted.

Any transmitted signal in PFB exceeding allowed duty cycle value shall be recorded in the test report.

Any signal measured outside PFB and exceeding spurious level shall be recorded in the test report.

5.4.11 FHSS equipment

5.4.11.1 Test conditions

- 1) The measurement shall be performed on the EUT nominal operating frequency.
- 2) The EUT shall be configured to transmit its maximum length transmissions.
- 3) Unless otherwise stated the observation bandwidth F_{obs} is the Permitted Frequency Band (PFB).
- 4) An EUT without a permanent or temporary antenna connector shall be tested according to clause 5.4.11.2.
- 5) An EUT with a permanent or temporary antenna connector shall be tested according to clause 5.4.11.3.

5.4.11.2 Radiated measurement

The measurements shall be performed using the procedure in clause 5.4.11.4 using a test selected according to clause D.6 and using corresponding radiated measurement methods described in clause D.5.1 (or clause D.5.2) depending on the test site, followed by clause D.5.3.

5.4.11.3 Conducted measurement

The EUT shall be connected to an artificial antenna which shall be connected to the test equipment. An attenuator shall be selected in order that the maximum RF power limit of the analyser is not exceeded.

The measurements in clause 5.4.11.4 shall be performed.

5.4.11.4 Measurement procedure

5.4.11.4.0 General

Spectrum analyser parameters are given by Table 46.

Table 46: Parameters for FHSS measurement

Spectrum Analyser Setting	Value	Notes
Sample rate	≥ 1 M samples/second	Sampling rate for at least 1 μ s resolution
Trigger	-	Trigger setting to capture leading edge of first transmission
SPAN	PFB	Permitted frequency band
Detector	Max peak	
Mode	Max hold	

5.4.11.4.1 Hopping channels

This measurement addresses clause 4.4.11.2 limits a), b) and c).

Step 1:

The EUT shall be set to operate for 10 transmissions with D-M3 signal.

Step 2:

Signal in each hopping channel shall be recorded and the number of hopping channels counted. The number of hopping channels used shall be noted in the test report. Operation in fewer channel than the minimum value in Table C.1 band V is not allowed.

5.4.11.4.2 FHSS occupied bandwidth

The hopping sequence shall be stopped. The EUT shall be set to operate with D-M3 signal in a single channel.

The occupied bandwidth shall be measured according to clause 5.4.4 and shall not exceed Table 2 value for bands V.

5.4.11.4.3 Dwell time

This measurement addresses clause 4.4.11.2 limit d).

One of the hopping channel shall be selected. The spectrum analyser shall be set to zero span with a RBW of at least OCW. Sweep time shall be set to 2 x epoch. The EUT shall transmit one transmission.

The dwell time of the transmission in the hopping channel shall be measured.

5.4.11.4.4 Channel return time

This measurement addresses clause 4.4.11.2 limits f) and g).

The EUT shall transmit one transmission. In the case that two successive signals are detected in the hopping channel, the time between these two successive signals shall be noted and shall be less than or equal to the lower of epoch and 20 seconds.

5.4.11.4.5 FHSS duty cycle

The duty cycle of transmission shall comply with clause 5.4.3 with the following conditions $T_{\text{obs}} = 1\text{h}$ and F_{obs} =permitted frequency band and shall not exceed the Table 2 value for band V.

NOTE: If measured dwell time is less or equal to 10 ms, a duty cycle restriction requirement applies as described in clause 4.11.3 item e).

5.4.11.4.6 FHSS CCA

This measurement addresses clause 4.4.11.2 limit h)

If the CCA feature is activated, the CCA threshold shall comply to conformance clause 5.6.1 with requirement specified in clause 4.4.11.3, item h1).

5.4.12 Short term behaviour

5.4.12.1 Test conditions

- 1) The measurement shall be performed on the EUT nominal operating frequency.
- 2) The EUT shall be configured to transmit its maximum length transmissions.
- 3) Unless otherwise specified, the observation period T_{obs} is 1 second.
- 4) Unless otherwise stated the observation bandwidth F_{obs} is the Permitted Frequency Band (PFB).
- 5) An EUT without a permanent or temporary antenna connector shall be tested according to clause 5.4.12.2.
- 6) An EUT with a permanent or temporary antenna connector shall be tested according to clause 5.4.12.3.

5.4.12.2 Radiated measurement

The measurements shall be performed using the procedure in clause 5.4.12.4 using a test site selected according to clause D.6 and using corresponding radiated measurement methods described in clause D.5.1 (or clause D.5.2) depending on the test site, followed by clause D.5.3.

A spectrum analyser is connected to the test antenna outside the site. It should be ensured by observation that the input stage of the measurement system is not saturated and that a high SNR is maintained to allow detection of the transmission at $P_{\text{threshold}}$ of -26 dBc. If necessary, a low noise amplifier may be used at spectrum analyser to improve the SNR.

The measurements in clause 5.4.12.4 shall be performed.

5.4.12.3 Conducted measurement

The EUT shall be connected to an artificial antenna which shall be connected to the spectrum analyser.

It should be ensured by observation that the input stage of the measurement system is not saturated and that a high SNR is maintained to allow detection of the transmission at $P_{\text{threshold}}$ of -26 dBc.

The measurements in clause 5.4.12.4 shall be performed.

5.4.12.4 Measurement procedure

The EUT signal shall be measured with a spectrum analyser and its levels adjusted according to the power envelope of the EUT transmissions.

For large observation periods T_{obs} continuous recording of the EUT signal may not be feasible due to memory limitations of the measurement equipment.

In this case acquisition of the signal is triggered on a defined power level. This trigger level should be lower than $P_{threshold}$ in order to capture the entire signal of interest. Upon triggering the signal is acquired for T_{obs} .

The acquired data is then time-stamped and stored in memory. With the next transmission the acquisition is triggered again, and so on, until T_{obs} has been reached as illustrated in Figure 8.

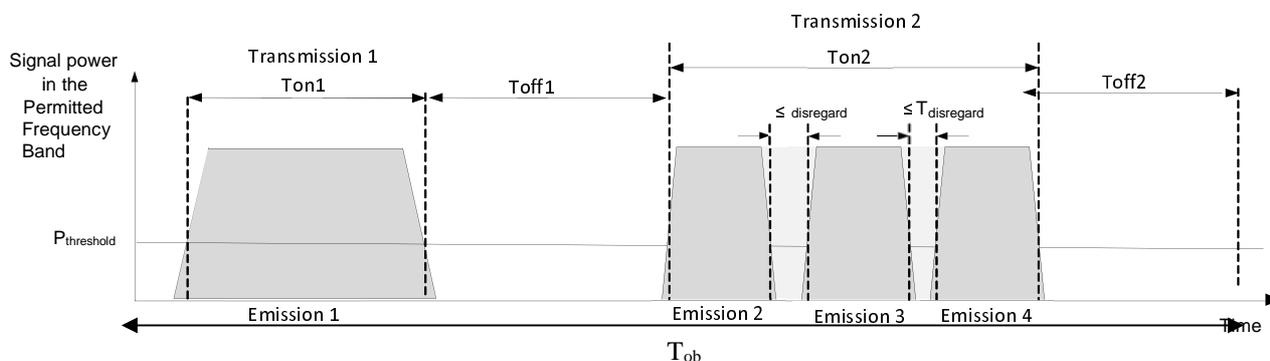


Figure 8: Illustration of acquisition time for short term behaviour

The spectrum analyser test equipment shall be configured in time domain according to the settings in Table 47.

Table 47: Spectrum analyser settings for short term behaviour measurement

Setting	Value	Notes
Centre frequency	EUT nominal operating frequency	See annex G
Span	0	
Sweep time	$2 \times T_{obs}$	
Sample rate	$\geq 1 \text{ M samples/second}$	Sampling rate for at least 1μ second resolution
RBW	F_{obs}	Permitted frequency band
Trigger		Trigger setting to capture leading edge of first transmission
$P_{threshold}$	-26 dBc	Signal threshold

Steps 1 to 3 shall be repeated for not less than 10 transmissions.

Step 1:

The EUT shall be set to operate.

The sampled power readings shall be saved.

Step 2:

Using an analysis software the start time and stop time of each sequence of samples above $P_{threshold}$ shall be obtained.

Between the saved start and stop times of each individual burst, the T_{on} time shall be calculated. These T_{on} values shall be saved.

Between the saved stop and start times of two subsequent bursts, the T_{off} time shall be calculated. These T_{off} values shall be saved.

NOTE 1: For low activity EUT, a note should be made if only a single transmission occurred.

Step 3:

Within the calculated T_{off} times, any interval less than $T_{disregard}$ shall be discarded. The lowest value of T_{off} shall be noted.

The transmission duration is the time between two consecutive T_{off} intervals. The highest value calculated for transmission duration shall be noted.

NOTE 2: If only a single transmission occurred the duration is calculated from the samples directly and the T_{off} time is the duration from the end of the transmission to the end of the sampling interval.

The information shown in Table 48 shall be recorded in the test report.

Table 48: Information recorded in the test report for short term behaviour

Value	Notes
EUT frequency	Nominal operating frequency
Measured sequence	$T_{\text{on cum}}$ and T_{off} measured with T_{obs} and F_{obs}

5.5 Conformance methods of measurement for receivers

5.5.1 Receiver sensitivity

5.5.1.1 Test conditions

- 1) An EUT without a permanent antenna connector shall be tested according to clause 5.5.1.2.
- 2) An EUT with a permanent antenna connector shall be tested according to clause 5.5.1.3.

5.5.1.2 Radiated measurement

A test site is selected according to clause D.6.

The output of the signal generator shall be connected to a transmit test antenna. The transmit test antenna shall be placed in the test site.

The EUT shall be placed at the location of the turntable at the orientation of the most sensitive position.

For a transceiver EUT, the most sensitive position is the same position as where the maximum e.r.p was measured. For receiver only EUT, the measurement test clause 5.5.1.4 shall be performed at different angles from the turntable until a maximum is reached.

The measurement in clause 5.5.1.4 shall be performed using a radiated measurement method described in clause D.5.4.

5.5.1.3 Conducted measurement

The EUT shall be connected to the output of a signal generator.

The measurements in clause 5.5.1.4 shall be performed.

5.5.1.4 Measurement procedure

The signal generator, modulated with a test signal selected from Table 18, shall be set to nominal operating frequency.

Step 1:

The operation of the EUT shall be started as a receiver on the nominal operating frequency.

Step 2:

The level of the input signal to the EUT shall be adjusted until the wanted criterion as described in clause 4.2.1 is just exceeded.

Step 3:

With the signal generator settings unchanged, the power received by the EUT shall be established.

The receiver sensitivity shall be noted.

Step 4:

Steps 1 to 3 shall be repeated for each data rate at which the EUT is able to operate.

Step 5:

The information shown in Table 49 shall be recorded in the test report.

Table 49: Information recorded in the test report

Value	Notes
Test signal	The test signal used
Data rate	EUT data rate
Measurement method	BER/message success ratio
Measurement description	Description of BER
EUT frequency	Nominal operating frequency tested
Receiver sensitivity	Power level at Rx input

5.5.2 Receiver dynamic range

5.5.2.1 Test conditions

- 1) The measurement shall be performed on the EUT set to the nominal operating frequency.
- 2) The measurements shall be performed for each data rate at which the EUT is intended to operate.
- 3) An EUT without a permanent or temporary antenna connector shall be tested according to clause 5.5.2.2.
- 4) An EUT with a permanent or temporary antenna connector shall be tested according to clause 5.5.2.3.

5.5.2.2 Radiated measurement

A test site is selected according to clause D.6.

The output of a signal generator shall be connected to a transmit test antenna. The transmit test antenna shall be placed in the test site.

The EUT shall be placed on the turntable in the test site.

The measurement in clause 5.5.2.4 shall be performed using radiated measurement methods described in clause D.5.4 corresponding to the selected test site.

5.5.2.3 Conducted measurement

The EUT shall be connected to the output of a signal generator.

The measurements in clause 5.5.2.4 shall be performed.

5.5.2.4 Measurement procedure

Step 1:

The signal generator, modulated with a permitted test signal selected from Table 18, shall be set to the nominal operating frequency.

The EUT shall be set to operate on the nominal operating frequency.

The signal generator shall be set to the minimum level which gives the wanted performance criterion of the EUT according to clause 5.5.1.

Step 2:

The EUT shall be started as a receiver.

Step 3:

The level of the input signal to the EUT shall be increased until the wanted criteria defined in clause 4.2.1 is no longer achieved or the limit specified in Table 10 is reached.

Step 4:

With the signal generator settings unchanged, the output of the signal generator shall be connected to an RF power measuring equipment.

For a conducted test:

- The power into the measuring equipment shall be measured.

For a radiated test:

- The power into the measuring equipment plus the gain of the test antenna minus cables losses shall be measured.

The information shown in Table 50 shall be recorded in the test report.

Table 50: Information recorded in the test report for maximum input signal level

Value	Notes
Test signal	The test signal used (see clause 5.2.9 Table 18)
Data rate	EUT data rate
EUT frequency	nominal operating frequency
Receiver dynamic range	Step 4 measured power level – Step 1 sensitivity level

Step 5:

Steps 1 to 4 shall be repeated for each data rate at which the EUT is intended to operate.

5.5.3 Adjacent channel selectivity

5.5.3.1 Test conditions

- 1) The measurement shall be performed on the EUT set to the nominal operating frequency.
- 2) An EUT without a permanent or temporary antenna connector shall be tested according to clause 5.5.3.2.
- 3) An EUT with a permanent or temporary antenna connector shall be tested according to clause 5.5.3.3.

5.5.3.2 Radiated measurement

A test site is selected according to clause D.6.

Signal generators A and B together with the combiner, shown in Figure 9, shall be placed outside the test site for full anechoic and semi anechoic rooms. For OATS, signal generators A and B with the combiner shall be on a table behind the transmit test antenna.

The output of the combiner shall be connected to a transmit test antenna. The transmit test antenna shall be placed in the test site.

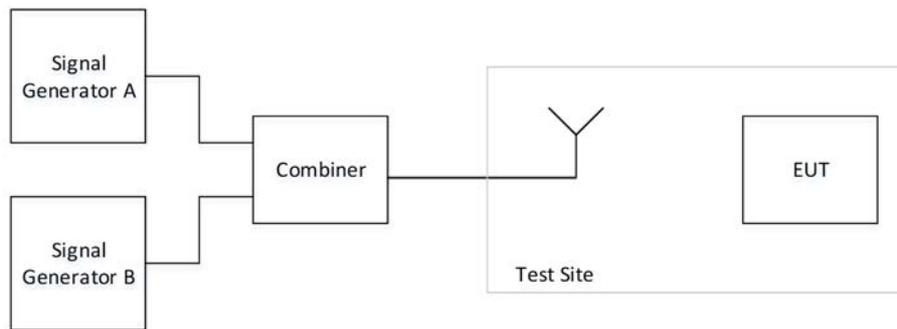


Figure 9: Radiated test measurement arrangement

The EUT shall be placed on the turntable at the orientation of the most sensitive position.

The measurements in clause 5.5.3.3 shall be performed using a radiated measurement method described in clause D.5.4.

5.5.3.3 Conducted measurement

Two signal generators A and B shall be connected to the EUT via a combining network as shown in Figure 10.

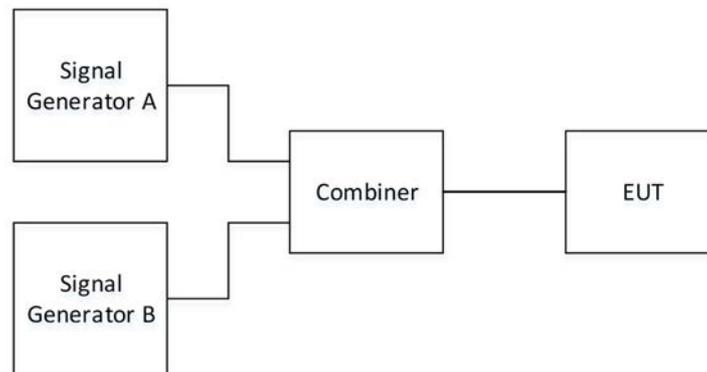


Figure 10: Conducted test measurement arrangement

The measurements in clause 5.5.3.4 shall be performed.

5.5.3.4 Measurement procedure

Signal generator A shall be configured to generate the wanted signal at the EUT nominal operating frequency.

Signal generator B shall be unmodulated and shall be adjusted to the nominal operating frequency + OCW i.e. the adjacent channel centre frequency immediately above the operating channel.

Signal generator B RF signal shall be muted.

Signal generator A shall be set to the minimum level which gives the wanted performance criterion of the EUT (as measured in clause 5.5.1) or the reference level in Table 9, whichever is the higher. The output level of signal generator A shall then be increased by 3 dB. Signal generator B is then unmuted and the signal amplitude is adjusted to the minimum level at which the wanted performance criterion is just not achieved.

The ACS is then the power received from generator B at the EUT antenna connector.

This can either be measured on the antenna connector in case of conducted tests or be calculated for radiated test (e.g. $ACS = Tx \text{ power generator B} - \text{combiner loss} + \text{antenna gain test antenna} + \text{antenna gain EUT} - \text{path loss}$) (see clause D.5.4).

The measurements shall be repeated with signal generator B adjusted to the nominal operating frequency - OCW i.e. the adjacent channel centre frequency immediately below the Operating Channel.

The information shown in Table 51 shall be recorded in the test report.

Table 51: Information recorded in the test report

Value	Notes
EUT frequency	Nominal operating frequency of the receiver
Upper Adjacent Channel Selectivity at $f_{nom} + OCW$	
Lower Adjacent Channel Selectivity at $f_{nom} - OCW$	

5.5.4 Blocking

5.5.4.1 Test conditions

- 1) The measurement is performed at the EUT nominal operating frequency.
- 2) An EUT without a permanent or temporary antenna connector shall be tested according to clause 5.5.4.2.
- 3) An EUT with a permanent or temporary antenna connector shall be tested according to clause 5.5.4.3.

5.5.4.2 Radiated measurement

A test site is selected according to clause D.6.

Signal generators A and B together with the combiner, shown in Figure 9, shall be placed outside the test site.

The output of the combiner shall be connected to a transmit test antenna. The transmit test antenna shall be placed in the test site.

The EUT shall be placed on the turntable at the orientation of the most sensitive position.

The measurements in clause 5.5.4.4 shall be performed using a radiated measurement method described in clause D.5.4.

5.5.4.3 Conducted measurement

Two signal generators A and B shall be connected to the EUT via a combining network as shown in Figure 10.

The measurements in clause 5.5.4.4 shall be performed.

5.5.4.4 Measurement procedure

Signal generator A shall be set to D-M3 test signal at the operating frequency of the EUT receiver.

Signal generator B shall be unmodulated.

Measurements shall be carried out at frequencies of the unwanted signal at the frequencies offsets defined in Table 12 avoiding those frequencies at which spurious responses occur. A spurious response frequency occurs where the blocking limit level from Table 12 is not met at the measurement point. In case of spurious response frequency at a blocking measurement point the spurious responses level limit applies at this point and an additional blocking measurement shall be performed at Table 12 offset +1 MHz for positive offset and at Table 12 offset -1 MHz for negative offset.

NOTE: Spurious responses are tested in clause 5.5.5.

Step 1:

Signal generator B shall be muted. Signal generator A shall be set to the minimum level which gives the wanted performance criterion of EUT (as measured in clause 5.5.1) or the reference level in Table 9, whichever is the higher. The output level of generator A shall then be increased by 3 dB unless otherwise specified in technical requirement.

Step 2:

Signal generator B is set to operate at the EUT nominal operating frequency - offset frequency.

Signal generator B is then unmuted and the signal amplitude is adjusted to the minimum level at which the wanted performance criterion is not achieved.

With signal generator B settings unchanged, the receiver shall be replaced with a suitable RF power measuring equipment. The power into the measuring equipment shall be measured and noted.

The blocking level is then the conducted power received from generator B at the EUT antenna connector or the radiated level of signal generator B available at EUT

This can be measured on the EUT antenna connector for conducted test.

For radiated test, the radiated level of signal generator B available at EUT is the signal generator B level - test site path loss at EUT position -path loss of combiner cables.

Step 3:

The measurement in steps 1 to 3 shall be repeated with signal offsets at required frequencies.

Step 4:

The information shown in Table 52 shall be recorded in the test report for each measured signal level and unwanted signal offset.

Table 52: Information Recorded in the Test Report

Value	Notes
EUT frequency	Nominal operating frequency
Test frequency(ies)	Tested frequencies
Blocking level at each tested frequency	Power level of signal generator B

For EUT using CCA, steps 1 to 4 shall be repeated with signal generator A level adjusted +13 dB higher than in the measurements in clause 5.5.4.4.

5.5.5 Receiver spurious response rejection

5.5.5.1 Test Conditions

- 1) The measurements shall be performed on the EUT nominal operating frequency.
- 2) An EUT without a permanent or temporary antenna connector shall be tested according to clause 5.5.5.2.
- 3) An EUT with a permanent or temporary antenna connector shall be tested according to clause 5.5.5.3.

5.5.5.2 Radiated measurement

A test site is selected according to clause D.6.

Signal generators A and B together with the combiner, shown in Figure 9, shall be placed outside the test site.

The output of the combiner shall be connected to a transmit test antenna. The transmit test antenna shall be placed in the test site.

The EUT shall be placed on the turntable at the orientation of the most sensitive position.

The measurements in clause 5.5.5.4 shall be performed.

5.5.5.3 Conducted measurement

Two signal generators A and B shall be connected to the EUT via a combining network as shown in Figure 10.

The measurements in clause 5.5.5.4 shall be performed.

5.5.5.4 Measurement procedure

Signal generator A shall be configured to generate the wanted signal at the nominal operating frequency of the EUT receiver.

Signal generator B shall be unmodulated and shall be adjusted to the test frequencies offsets as determined by the first column of Table 12 and where a spurious response was detected in blocking parameter measurement clause 5.5.4.4.

NOTE: Frequencies at which spurious responses may occur are:

1) Receivers with intermediate frequency:

- 1a) frequency of the local oscillator signal (f_{LO}) applied to the first mixer of the receiver plus or minus the Intermediate Frequency (IF) ($f_{LO} \pm f_{IF}$) or where more than one IF is involved, at the image frequency of the first and subsequent frequency conversions ($f_{LO} \pm f_{IF1}$) and ($f_{LO} \pm f_{IF2}$);
- 1b) at frequency separation corresponding to half of the first IF from the nominal operating frequency (f_{nom}): $f_{nom} \pm (f_{IF1}/2)$.

For the calculations 1a) and 1b) above, the frequency of the local oscillator signal (f_{LO}) applied to the first mixer of the receiver, the intermediate frequencies (f_{IF1} , f_{IF2} , etc.) are EUT properties (annex G).

Signal generator B shall be switched off. Signal generator A shall be set to the minimum level which gives the wanted performance criterion of EUT (as measured in clause 5.5.1) or the reference level in Table 9, whichever is the higher .

The output level of generator A shall then be increased by 3 dB.

Signal generator B is then switched on and the signal amplitude is adjusted to the minimum level at which the wanted performance criterion is not achieved.

The spurious response rejection is then the conducted power received from signal generator B at the EUT antenna connector.

This can either be measured on the antenna connector for conducted test or be calculated for radiated test (see clause D.5.4).

The information shown in Table 53 shall be recorded in the test report for each measurement.

Table 53: Information recorded in the test report

Value	Notes
Rx operating frequency	Nominal operating frequency of the receiver
Test frequency(ies)	Frequency of signal generator B
Spurious response rejection level	Power level of signal generator B
NOTE:	If several Operational Frequency bands are used by the equipment, measurement have to be performed in each band.

5.5.6 Receiver intermodulation rejection

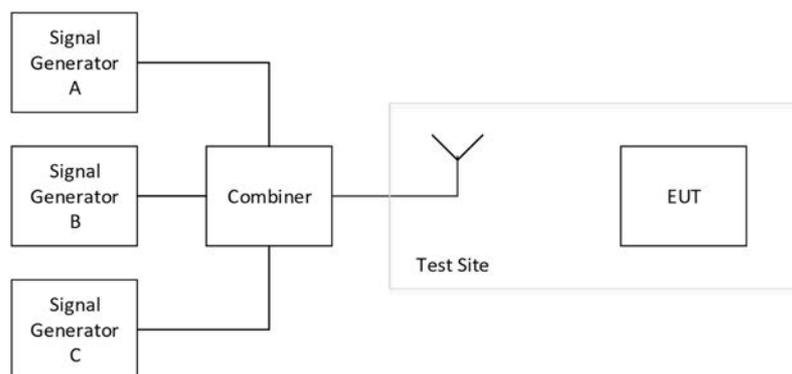
5.5.6.1 Test conditions

- 1) The measurement is performed on the EUT nominal operating frequency.
- 2) An EUT without a permanent or temporary antenna connector shall be test according to clause 5.5.6.2.
- 3) An EUT with a permanent or temporary antenna connector shall be test according to clause 5.5.6.3.
- 4) Test parameter settings are described in Table 54.

Table 54: Test parameter settings for receiver intermodulation measurement

Setting	Value
EUT operating frequency	Nominal operating frequency of the receiver
Signal generator A frequency	The EUT nominal operating frequency
Offset _b	2 x OCW
Offset _c	4 x OCW

5.5.6.2 Radiated measurement procedure

**Figure 11: Receiver intermodulation rejection radiated measurement arrangement**

A test site is selected according to clause D.6.

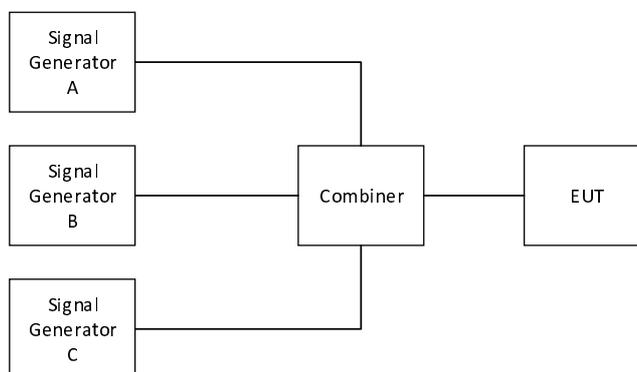
Signal generators A, B and C together with the combiner, arranged as shown in Figure 11, shall be placed outside the test site.

The output of the combiner shall be connected to a transmit test antenna with the same antenna polarization as the EUT. The transmit test antenna shall be placed in the test site.

The EUT shall be placed on the turntable in the test site in the orientation of the most sensitive position.

The measurements specified in clause 5.5.6.4 shall be performed using radiated measurement methods described in clause D.5.4. corresponding to the selected test site.

5.5.6.3 Conducted measurement procedure

**Figure 12: Receiver intermodulation rejection conducted measurement arrangement**

Signal generators A, B and C shall be connected to the EUT via a combining network as shown in Figure 12.

The measurement specified in clause 5.5.6.4 shall be performed.

5.5.6.4 Measurement procedure

Step 1:

Signal generator A shall be configured to generate the wanted signal at the nominal operating frequency of the EUT receiver.

Signal generator B shall be set to operate at the EUT nominal operating frequency + Offset_B (as specified in Table 54).

Signal generator C shall be set to operate at the EUT nominal operating frequency + Offset_C (as specified in Table 54).

Signal generators B and C shall be powered off.

The level of signal generator A shall be adjusted to the lowest level that provides the wanted criteria (see clause 4.2.1). With signal generator A settings unchanged, the connection to the combiner shall be replaced with a connection to an RF power measuring equipment. The power from signal generator A into the measuring equipment shall be measured and noted as P_{wanted}.

The output level of generator A shall then be increased by 3 dB.

Step 2:

Signal generator B shall be powered on and its output shall be unmodulated.

Signal generator C shall be powered on and its output shall be modulated with D-M2 test signal.

The output power of signal generators B and C shall be maintained at the same level.

Step 3

The output levels of signal generators B and C shall be increased until the wanted criteria (see clause 4.2.1) is no longer achieved.

With signal generator B settings unchanged, the connection to the combiner shall be replaced with a connection to an RF power measuring equipment.

The power from signal generator B into the measuring equipment shall be measured and noted as P_{upper}.

Step 4:

Signal generator B shall be set to operate at signal EUT nominal operating frequency – Offset_B

Signal generator C shall be set to operate at EUT nominal operating frequency – Offset_C

Step 5:

The output levels of signal generators B and C shall be increased until the wanted criteria (see clause 4.2.1) is no longer obtained.

With signal generator B settings unchanged, the connection to the combiner shall be replaced with a connection to an RF power measuring equipment.

The power from signal generator B into the measuring equipment shall be measured and noted as P_{lower}.

Table 55: Information shall be recorded in the test report for receiver intermodulation rejection

Value	Notes
Test signal	The test signal used (see Table 18)
P _{upper} (dBm)	Measured unwanted signal power in dBm for offset above the EUT nominal operating frequency
P _{lower} (dBm)	Measured unwanted signal power in dBm for offset below the EUT nominal operating frequency
P _{wanted} (dBm)	The measured power in dBm from signal generator A
Receiver intermodulation rejection (dB)	Higher of (P _{upper} – P _{wanted}) and (P _{lower} – P _{wanted})

5.6 Conformance methods of measurement for polite spectrum access

5.6.1 Clear Channel Assessment threshold

5.6.1.1 Test conditions

- 1) The measurement is performed on the EUT nominal operating frequency.
- 2) An EUT without a permanent or temporary antenna connector shall be tested according to clause 5.6.1.2.
- 3) An EUT with a permanent or temporary antenna connector shall be tested according to clause 5.6.1.3.

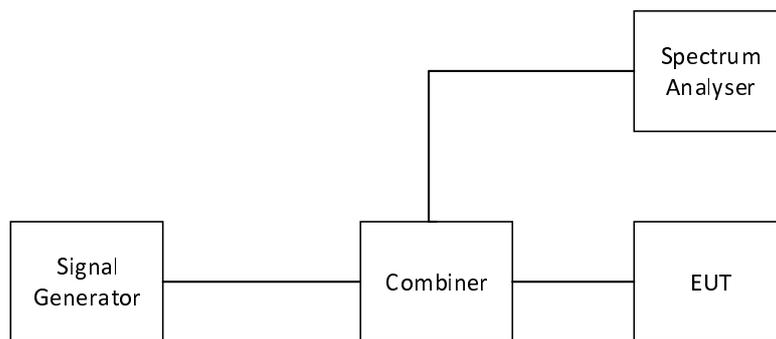


Figure 13: Conducted clear channel assessment threshold measurement arrangement

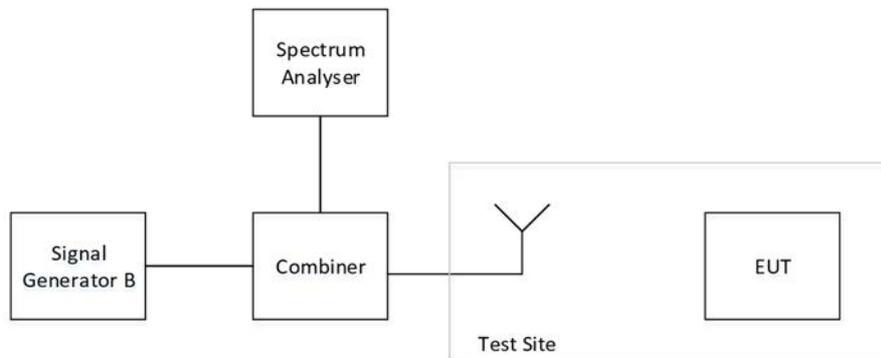


Figure 14: Radiated clear channel assessment threshold measurement arrangement

5.6.1.2 Radiated measurement

A test site is selected according to clause D.6.

The signal generator together with the combiner and spectrum analyser, as shown in Figure 14, shall be placed outside the test site.

The output of the combiner shall be connected to a transmit test antenna. The transmit test antenna shall be placed in the test site.

The EUT shall be on the turntable in the orientation of the most sensitive position.

The measurement in clause 5.6.1.4 shall be performed using radiated measurement methods described in clause D.5.4 corresponding to the selected test site.

5.6.1.3 Conducted measurement

A signal generator and a spectrum analyser shall be connected to the EUT antenna connector via a combining network as shown in Figure 13.

The measurements in clause 5.6.1.4 shall be performed.

5.6.1.4 Measurement procedure

Table 56: Test parameters settings for CCA threshold measurement

Setting	Value
Centre frequency	The nominal EUT operating frequency
RBW	3 x OCW
VBW	3 x RBW
Span	Zero span
Detector Mode	RMS
Trace Mode	Max. Hold

The spectrum analyser shall be configured for the parameters specified in Table 56.

Step 1:

Operation of the EUT as a receiver shall be started with its CCA function active.

The signal generator, modulated with a DM-2 test signal, shall be adjusted at nominal operating frequency.

The spectrum analyser levels shall be adjusted to provide satisfactory display of the signal generator signal.

Step 2:

The output power level of the signal generator shall be set to 20 dB above the receiver sensitivity limit given in clause 4.5.1

The EUT shall be instructed to transmit.

NOTE 1: The means of instructing the EUT to transmit is outside the scope of the present document.

The presence of any signal from the EUT detected by the spectrum analyser shall be noted.

NOTE 2: Allowance should be made for any EUT specific protocol delays associated with CCA operation before determining whether the EUT emits a signal or not.

Step 3:

The level of the signal generator shall be reduced in steps of 1 dB until the equipment starts to transmit.

NOTE 3: There may be EUT specific protocol delays associated with collision avoidance operation before the EUT begins to transmit once the CCA threshold has been reached. Any such delays should be taken into account in the rate at which the signal generator level is reduced.

Step 4:

With the signal generator settings unchanged, the output of the signal generator shall be connected to an RF power measuring equipment.

The power into the measuring equipment shall be measured and noted.

For a conducted test:

- The power into the measuring equipment shall be measured.

For a radiated test:

- The power into the measuring equipment plus the gain of the test antenna minus cables losses shall be measured.

The measured RF power level is the CCA threshold and shall be noted.

The information shown in Table 57 shall be recorded in the test report.

Table 57: Information recorded in the test report for CCA threshold

Value	Notes
Test signal	The test signal used (see clause 5.2.9)
CCA threshold	CCA threshold power level
Presence of unexpected EUT signal	Any transmission detected at the spectrum analyser in step 2
NOTE: The presence of unexpected EUT transmission is a test failure.	

5.6.2 Polite spectrum access timing parameters

5.6.2.1 Test conditions

- 1) The measurement is performed on the EUT nominal operating frequency.
- 2) An EUT without a permanent or temporary antenna connector shall be tested according to clause 5.6.2.2.
- 3) An EUT with a permanent or temporary antenna connector shall be tested according to clause 5.6.2.3.

5.6.2.2 Radiated measurement

A test site is selected according to clause D.6.

The output of the signal generator shall be connected to a transmit test antenna with the same antenna polarization as the EUT. The transmit test antenna shall be placed in the test site.

The arbitrary function generator, signal generator together with the combiner and spectrum analyser, as shown in Figure 15, shall be placed outside the test site.

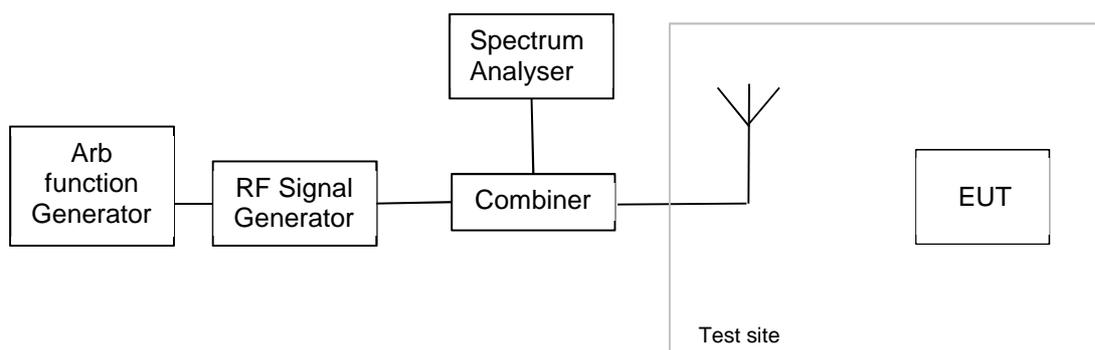


Figure 15: Radiated CCA time measurement arrangement

If the RF generator can be programmed to perform the required functions, the arbitrary function generator may not be needed, otherwise the arbitrary function generator output shall be connected to the input of the RF signal generator that enables the carrier.

The measurement in clause 5.6.2.4 shall be performed using a radiated measurement method described in clause D.5.4.

5.6.2.3 Conducted measurement

The EUT shall be connected to the output of a signal generator.

A signal generator and a spectrum analyser shall be connected to the EUT antenna connector via a combining network as shown in Figure 16.

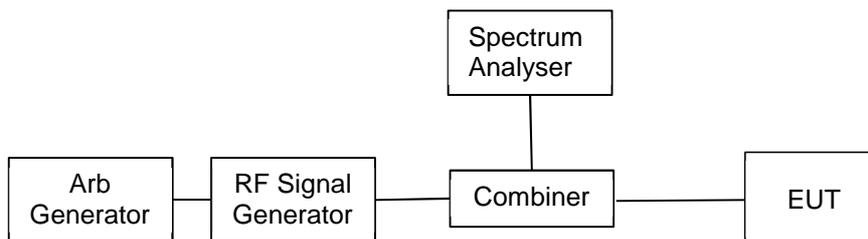


Figure 16: Conducted CCA time measurement arrangement

If the RF generator can be programmed to perform the required functions, the arbitrary function generator may not be needed, otherwise the arbitrary function generator output shall be connected to the input of the RF signal generator that enables the carrier.

The measurements in clause 5.6.2.4 shall be performed.

5.6.2.4 Measurement procedure

5.6.2.4.1 Minimum CCA interval

The spectrum analyser, RF signal generator and arbitrary generator shall be configured for the parameters specified in Table 58.

Table 58: Test parameters settings for minimum CCA interval test

Setting	Value
Spectrum analyser	
Centre frequency	The nominal EUT operating frequency
RBW	OCW
VBW	3 x RBW
Span	Zero span
Detector Mode	RMS
Trace Mode	Max. Hold
Signal generator	
Centre frequency	The nominal EUT operating frequency
Modulation	Unmodulated controlled by Pulse input
Pulse input configuration	Pulse input on means Carrier on, pulse input off means carrier off
Power level	20 dB above Rx sensitivity limits given in clause 4.5.1.3 or 5 dB above CCA threshold value given in clause 4.6.2.3
Arbitrary generator	
Enable signal	Enable signal with programmable value of the off interval T as in Figure 17

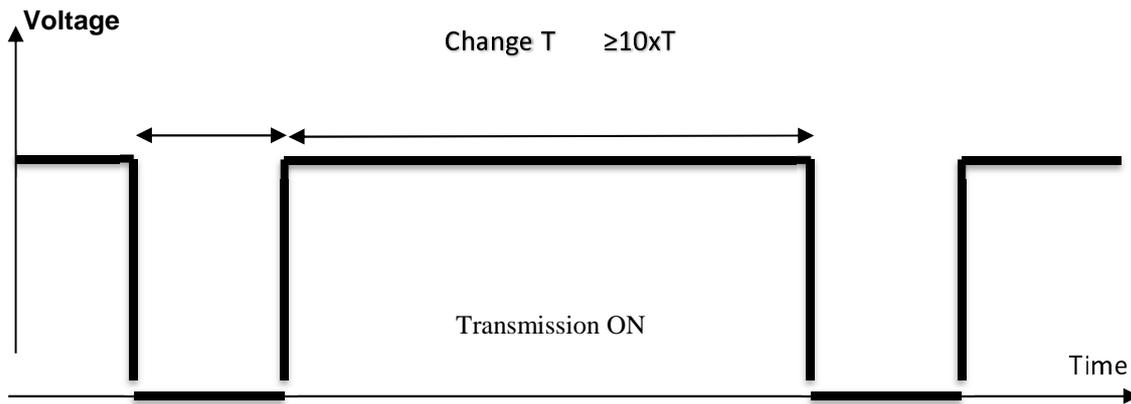


Figure 17: Arbitrary generator Enable signal

Step 1:

Operation of the EUT shall be started with its CCA and AFA functions active.

The spectrum analyser level shall be adjusted to provide satisfactory display of the signal generator signal.

The EUT shall be instructed to transmit.

NOTE: The means of instructing the EUT to transmit is outside the scope of the present document.

The presence of any signal from the EUT detected by the spectrum analyser shall be noted.

Step 2:

The off time starting value T is $120\mu\text{s}$ and T is increased until EUT starts to transmit one frame.

When an EUT transmission is detected on the same Operating Channel by the spectrum analyser, T value shall be noted as CCA time interval value. The information shown in Table 59 shall be recorded in the test report.

Table 59: Information recorded in the test report for CCA interval

Value	Notes
Presence of unexpected EUT signal	Any transmission detected at the spectrum analyser in step 2
CCA interval T	T shall be \geq minimum CCA interval time limit
NOTE: The presence of unexpected EUT transmission in step 1 or with $T < 160\mu\text{s}$ is a test failure.	

5.6.2.4.2 Transmission duration

The EUT shall be configured to transmit its maximum length transmissions. The signal generator shall be switched off.

Max T_{on} and minimum $T_{\text{off_min}}$ times are measured according to clause 5.4.12 with an observation period T_{obs} of 10 seconds and $F_{\text{obs}} = \text{OCW}$.

The information shown in Table 60 shall be recorded in the test report instead of Table 48.

Table 60: Information recorded in the test report for transmission timings

Value	Notes
EUT frequency	Nominal operating frequency
Max T_{on}	Maximum T_{on} measured with $T_{\text{obs}}=10\text{ s}$ and $F_{\text{obs}}=\text{OCW}$
$T_{\text{off_min}}$	Minimum T_{off} measured with $T_{\text{obs}}=10\text{ s}$ and $F_{\text{obs}}=\text{OCW}$

5.6.2.4.3 Maximum allowed Cumulative On Time

The EUT shall be instructed to transmit its maximum length transmissions.

Max T_{cum_on} is measured according to clause 5.4.12 with $T_{obs} = 1$ h and $F_{obs} = 200$ kHz.

The information shown in Table 61 instead of Table 48 shall be recorded in the test report.

Table 61: Information recorded in the test report for transmission timings

Value	Notes
EUT frequency	Nominal operating frequency
Max T_{cum_on}	Max T_{cum_on} measured with $T_{obs} = 1$ h and $F_{obs} = 200$ kHz

Annex A (informative): Relationship between the present document and the essential requirements of Directive 2014/53/EU

The present document has been prepared under the Commission's standardisation request C(2015) 5376 final [i.5] to provide one voluntary means of conforming to the essential requirements of Directive 2014/53/EU on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC [i.2].

Once the present document is cited in the Official Journal of the European Union under that Directive, compliance with the normative clauses of the present document given in table A.1 confers, within the limits of the scope of the present document, a presumption of conformity with the corresponding essential requirements of that Directive, and associated EFTA regulations.

Table A.1: Relationship between the present document and the essential requirements of Directive 2014/53/EU

Harmonised Standard ETSI EN 300 220-2					
Requirement				Requirement Conditionality	
No	Description	Essential requirements of Directive	Clause(s) of the present document	U/C	Condition
1	Unwanted emissions in the spurious domain	3.2	4.3.1	U	
2	Tx effective radiated power	3.2	4.4.1	U	
3	Tx maximum e.r.p. power spectral density	3.2	4.4.2	C	Applies to equipment transmitting in band I. Applies to equipment using DSSS and any techniques other than FHSS transmitting in band W.
4	Tx Duty cycle	3.2	4.4.3	C	Applies to all equipment except equipment transmitting with polite spectrum access in bands K, L, M, N, O, Q or W.
5	Tx maximum occupied bandwidth	3.2	4.4.4	U	
6	Tx frequency stability	3.2	4.4.5	U	
7	Tx out of band emissions	3.2	4.4.6	C	Applies to equipment with OCW > 25 kHz.
8	Tx Adjacent channel power	3.2	4.4.7	C	Applies to equipment with OCW ≤ 25 kHz.
9	Tx spectrum mask at frequency edges	3.2	4.4.8	U	
10	Tx Transient	3.2	4.4.9	U	
11	Tx behaviour under low voltage conditions	3.2	4.4.10	C	Applies to battery powered equipment
12	Tx FHSS equipment	3.2	4.4.11	C	Applies to FHSS equipment transmitting in band V.
13	Tx short term behaviour	3.2	4.4.12	C	Applies to equipment transmitting in band X or band Y.
14	Rx sensitivity	3.2	4.5.1	U	
15	Rx dynamic range	3.2	4.5.2	U	
16	Rx adjacent channel selectivity	3.2	4.5.3	C	Applies to equipment using band D or band J.
17	Rx blocking	3.2	4.5.4	U	
18	Rx spurious response rejection	3.2	4.5.5	U	
19	Rx intermodulation rejection	3.2	4.5.6	C	Applies to equipment using band D or band J.
20	Clear channel assessment threshold	3.2	4.6.2	C	Applies to equipment transmitting in bands K, L, M, N, O, Q, or V, W. with polite spectrum access
21	Polite spectrum access timing parameters	3.2	4.6.3	C	Applies to equipment transmitting in bands K, L, M, N, O, Q or V, W. with polite spectrum access

Key to columns:**Requirement:**

No A unique identifier for one row of the table which may be used to identify a requirement.

Description A textual reference to the requirement.

Essential requirements of Directive

Identification of article(s) defining the requirement in the Directive.

Clause(s) of the present document

Identification of clause(s) defining the requirement in the present document unless another document is referenced explicitly.

Requirement Conditionality:

U/C Indicates whether the requirement is unconditionally applicable (U) or is conditional upon the manufacturer's claimed functionality of the equipment (C).

Condition Explains the conditions when the requirement is or is not applicable for a requirement which is classified "conditional".

Presumption of conformity stays valid only as long as a reference to the present document is maintained in the list published in the Official Journal of the European Union. Users of the present document should consult frequently the latest list published in the Official Journal of the European Union.

Other Union legislation may be applicable to the product(s) falling within the scope of the present document.

Annex B (informative): EU wide harmonised national radio interfaces from 25 MHz to 1 000 MHz

Table B.1 summarizes the harmonised frequency bands and their technical key parameters for non specific short-range devices in EC Decision 2019/1345/EU [i.3].

Table B.1: EU wide harmonised national radio interfaces from 25 MHz to 1 000 MHz

Permitted Frequency Band		Maximum effective radiated power, e.r.p.	Channel access and occupation rules (e.g. Duty cycle or LBT + AFA)	Maximum occupied bandwidth	Other usage restrictions	Band number in EC Decision 2019/1345/EU [i.3]	Channel spacing in EC Decision 2019/1345/EU [i.3]
A	26,957 MHz to 27,283 MHz	10 mW e.r.p.	No requirement	The whole band		28	
B	26,99 MHz to 27,00 MHz 27,04 MHz to 27,05 MHz 27,09 MHz to 27,00 MHz 27,14 MHz to 27,15 MHz 27,19 MHz to 27,20MHz	100 mW e.r.p.	$\leq 0,1$ % duty cycle	The whole band	Model control equipment may operate without duty cycle restrictions.	29, 30, 31, 32, 33	
C	40,660 MHz to 40,700 MHz	10 mW e.r.p.	No requirement	The whole band		35	
D	169,400 MHz to 169,475 MHz	500 mW e.r.p.	$\leq 1,0$ % duty cycle For metering equipment duty cycle limit is 10 %	50 kHz		37c	50 kHz
E	169,4000 MHz to 169,4875 MHz	10 mW	$\leq 0,1$ % duty	The whole band		38	
F	169,4875 MHz to 169,5875 MHz	10 mW	$\leq 0,001$ % duty cycle Between 00.00 and 06.00 local time a duty cycle limit of 0,1 % may be used	The whole band		39b	
G	169,5875 MHz to 169,8125 MHz	10 mW	$\leq 0,1$ % duty cycle	The whole band		40	
H	433,050 MHz to 434,790 MHz	10 mW	10 %	The whole band		44b	

Permitted Frequency Band		Maximum effective radiated power, e.r.p.	Channel access and occupation rules (e.g. Duty cycle or LBT + AFA)	Maximum occupied bandwidth	Other usage restrictions	Band number in EC Decision 2019/1345/EU [i.3]	Channel spacing in EC Decision 2019/1345/EU [i.3]
I	433,050 MHz to 434,790 MHz	1 mW e.r.p. -13 dBm/10 kHz power spectral density for bandwidth modulation larger than 250 kHz	No requirement	The whole band	Voice applications allowed with advanced mitigation technique. Other audio video applications are excluded	44a	
J	434,040 MHz to 434,790 MHz	10 mW	No requirement	25 kHz	Voice applications allowed with advanced mitigation technique. Other audio video applications are excluded	45c	25 kHz
K0	862 MHz to 863 MHz	25 mW	$\leq 0,1$ % duty cycle	350 kHz		87	
K	863 MHz to 865 MHz	25 mW e.r.p.	$\leq 0,1$ % duty cycle or polite spectrum access	The whole band		46a	
L	865 MHz to 868 MHz	25 mW e.r.p.	≤ 1 % duty cycle or polite spectrum access	The whole band		47	
M	868,000 MHz to 868,600 MHz	25 mW e.r.p.	≤ 1 % duty cycle or polite spectrum access	The whole band		48	
N	868,700 MHz to 869,200 MHz	25 mW e.r.p.	$\leq 0,1$ % duty cycle or polite spectrum access	The whole band		50	
O	869,400 MHz to 869,650 MHz	500 mW e.r.p.	≤ 10 % duty cycle or polite spectrum access	The whole band		54	
P	869,700 MHz to 870,000 MHz	5 mW e.r.p.	No requirement	The whole band	Voice applications allowed with advanced mitigation technique. Other audio and video applications are excluded	56a	

Permitted Frequency Band		Maximum effective radiated power, e.r.p.	Channel access and occupation rules (e.g. Duty cycle or LBT + AFA)	Maximum occupied bandwidth	Other usage restrictions	Band number in EC Decision 2019/1345/EU [i.3]	Channel spacing in EC Decision 2019/1345/EU [i.3]
Q	869,700 MHz to 870,000 MHz	25 mW e.r.p.	≤ 1 % duty cycle or polite spectrum access	The whole band		56b	

NOTE: In the European Commission Decision on Short Range Devices [i.3], some harmonised frequency bands may be subject to usage restrictions such as the exclusion of video or audio use.

Annex C (informative): National Radio Interfaces not EU wide harmonised

In addition to EU wide harmonised radio interfaces listed in annex B, EU and EFTA member states may implement NRIs with associated technical requirements to ensure spectrum compatibility. Usually these requirements come from CEPT/ERC/REC 70-03 [i.1] which sets out the general position on spectrum designations for Short Range Devices (SRDs) for countries within the CEPT.

Table C.1 provides a list of these NRIs which might be available in some EU countries.

Table C.1: National Radio Interfaces not EU wide harmonised

	Permitted Frequency Band	Maximum Effective Radiated Power	Channel access and occupation rules	Additional spectrum access parameters	Maximum occupied bandwidth	Other usage restriction	Band number in CEPT/ERC/REC 70-03 [i.1]
R	34,995 MHz to 35,225 MHz	100 mW e.r.p.	No requirement		10 kHz	Only for Flying radio models	Annex 8; b
S	40,66 MHz to 40,67MHz, 40,67 MHz to 40,68MHz, 40,68 MHz to 40,69MHz, 40,69 MHz to 40,70MHz	100 mW e.r.p.	No requirement		10 kHz	Only for radio models	Annex 8, c1, c2, c3, c4
T	138,20 MHz to 138,45 MHz	10 mW e.r.p.	≤ 1,0 % duty cycle		The whole band		Annex 1; e
V	863 MHz to 870 MHz	25 mW e.r.p.	≤ 0,1 % duty cycle	The duty cycle applies to the entire transmission (not to each hop channel) Minimum of 47 channels	100 kHz	Applies only to equipment using FHSS technique Sub-bands for alarms 868,6 MHz to 868,7 MHz, 869,250 MHz to 869,4 MHz, 869,650 MHz to 869,700 MHz are excluded	Annex 1; h1.0

Permitted Frequency Band		Maximum Effective Radiated Power	Channel access and occupation rules	Additional spectrum access parameters	Maximum occupied bandwidth	Other usage restriction	Band number in CEPT/ERC/REC 70-03 [i.1]
W	863 MHz to 870 MHz	25 mW e.r.p. Power spectral density: -4,5 dBm/100 kHz.	$\leq 0,1$ % duty cycle or polite spectrum access		The whole band	Applies only to equipment using DSSS and any techniques other than FHSS Sub-bands 868,6 MHz to 868,7 MHz, 869,250 MHz to 869,4 MHz, 869,650 MHz to 869,700 MHz for alarms are excluded	Annex 1; h1.2
X	870,000 MHz to 874,400 MHz	25 mW e.r.p.	≤ 1 % duty cycle For ER-GSM protection (873 MHz to 875,8 MHz, where applicable), the duty cycle is limited to $\leq 0,01$ % and T_{on_max} is limited to 5 ms/1 s		600 kHz	See note, Use of REC 70-03 [i.1], annex 2 set of parameters is recommended for new designs	Annex 1; h2

Permitted Frequency Band		Maximum Effective Radiated Power	Channel access and occupation rules	Additional spectrum access parameters	Maximum occupied bandwidth	Other usage restriction	Band number in CEPT/ERC/REC 70-03 [i.1]
Y	915,000 MHz to 919.400 MHz	25 mW e.r.p. except for the 4 channels for the 4 channels identified in channel with centre frequencies at 916,3 MHz, 917,5 MHz, 918,7 MHz and 919,9 MHz, where 100 mW e.r.p. applies.	$\leq 1\%$ duty cycle For ER-GSM protection (918 MHz to 920,8 MHz, where applicable), the duty cycle is limited to $\leq 0,01\%$ and T_{on_max} is limited to 5 ms/1 s		600 kHz except for the 4 channels identified in channel with centre frequencies at 916,3 MHz, 917,5 MHz, 918,7 MHz and 919,9 MHz. where the bandwidth is limited to 400 kHz	See note Use of REC 70-03 [i.1], annex 2 set of parameters is recommended for new designs	Annex 1; h3
NOTE: Additional permitted frequency bands may be available in National Radio Interfaces. Manufacturers shall check the most recently published version of National Radio Interfaces in European Frequency Information System https://efis.cept.org/ . Use of all or part of sub-bands X and Y may be denied in some European countries that use all or part of these sub-bands for defence/governmental systems. In some member states the upper sub-bands 873 MHz to 876 MHz and 918 MHz to 921 MHz are allocated to the railways for ER-GSM. For the case that a frequency allocation is available in those countries for SRDs, sharing of these sub-bands by SRDs with ER-GSM is permitted provided SRD systems operate in accordance with agreed mitigation measures such as transmission timing limitations as set out in ECC Report 200 [i.6]. The required timing restrictions are included in the column "Channel access and occupation rules". See Appendix 3 of CEPT/ERC/REC 70-03 [i.1] for national implementation concerning ER-GSM and defence/governmental services.							

The adjacent frequency bands below 862 MHz and above 870 MHz may be used by high power systems. The same applies to the bands below 915 MHz and above 876 MHz as well as above 921 MHz. Manufacturers should take this into account in the design of equipment receiver and choice of power levels.

Annex D (normative): Test sites and arrangements for radiated measurement

D.0 Introduction

This annex introduces the three most commonly available test sites to be used in the radiated measurements in accordance with the present document.

Subsequently the following items will be described:

- Open Area Test Site (OATS);
- Semi Anechoic Room (SAR);
- Fully Anechoic Room (FAR).

These three are generally referred to as free field test sites. Both absolute and relative measurements can be performed on these sites. They will be described in clause D.1. Clause D.2 describes the antennas used in these test sites.

Where absolute measurements are to be carried out, the test site should be verified. A detailed verification procedure is described in clause 6 of ETSI TR 102 273-4 [i.12] for the OATS, in clause 6 of ETSI TR 102 273-3 [i.11] for the SAR, and in clause 6 of ETSI TR 102 273-2 [i.10] for the FAR.

Information for calculating the measurement uncertainty of measurements on one of these test sites can be found in ETSI TR 100 028-1 [i.9] and ETSI TR 100 028-2 [i.9], ETSI TR 102 273-2 [i.10], ETSI TR 102 273-3 [i.11] and ETSI TR 102 273-4 [i.12].

D.1 Radiation test sites

D.1.1 Open Area Test Site (OATS)

An Open Area Test Site comprises a turntable at one end and an antenna mast of variable height at the other end above a ground plane which, in the ideal case, is perfectly conducting and of infinite extent. In practice, while good conductivity can be achieved, the ground plane size has to be limited. A typical Open Area Test Site is shown in Figure D.1.

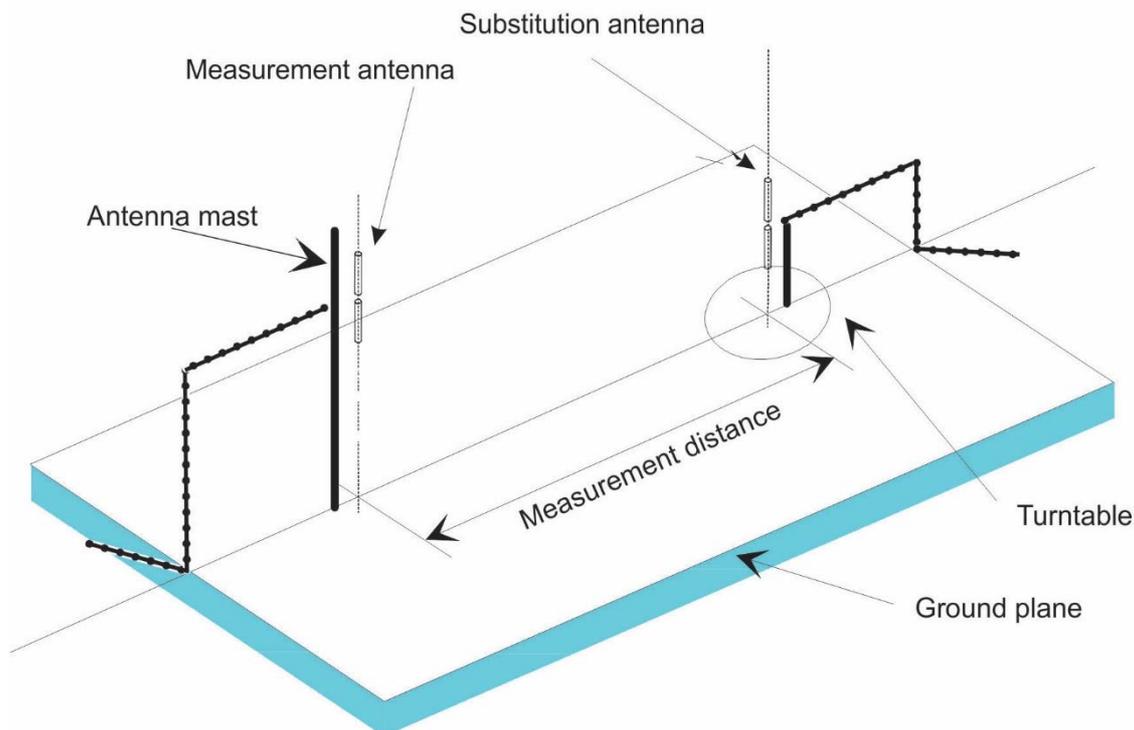


Figure D.1: A typical Open Area Test Site

The ground plane creates a wanted reflection path, such that the signal received by the receiving antenna is the sum of the signals received from the direct and reflected transmission paths. The phasing of these two signals creates a unique received level for each height of the transmitting antenna (or EUT) and the receiving antenna above the ground plane.

The antenna mast provides a variable height facility (from 1 m to 4 m) so that the position of the measurement antenna can be optimized for maximum coupled signal between antennas or between a EUT and the measurement antenna.

A turntable is capable of rotation through 360° in the horizontal plane and it is used to support the test sample (EUT) at a specified height, usually 1,5 m above the ground plane.

The measurement distance can be found in clause D.1.4. The distance used in actual measurements shall be recorded with the test results.

Further information on Open Area Test Sites can be found in ETSI TR 102 273-4 [i.12].

D.1.2 Semi Anechoic Room (SAR)

A Semi Anechoic Room or anechoic chamber with a conductive ground plane is an enclosure, usually shielded, whose internal walls and ceiling are covered with radio absorbing material. The floor, which is metallic, is not covered by absorbing material and forms the ground plane. The chamber usually contains an antenna mast at one end and a turntable at the other end. A typical anechoic chamber with a conductive ground plane is shown in Figure D.2.

This type of test chamber attempts to simulate an ideal Open Area Test Site, whose primary characteristic is a perfectly conducting ground plane of infinite extent.

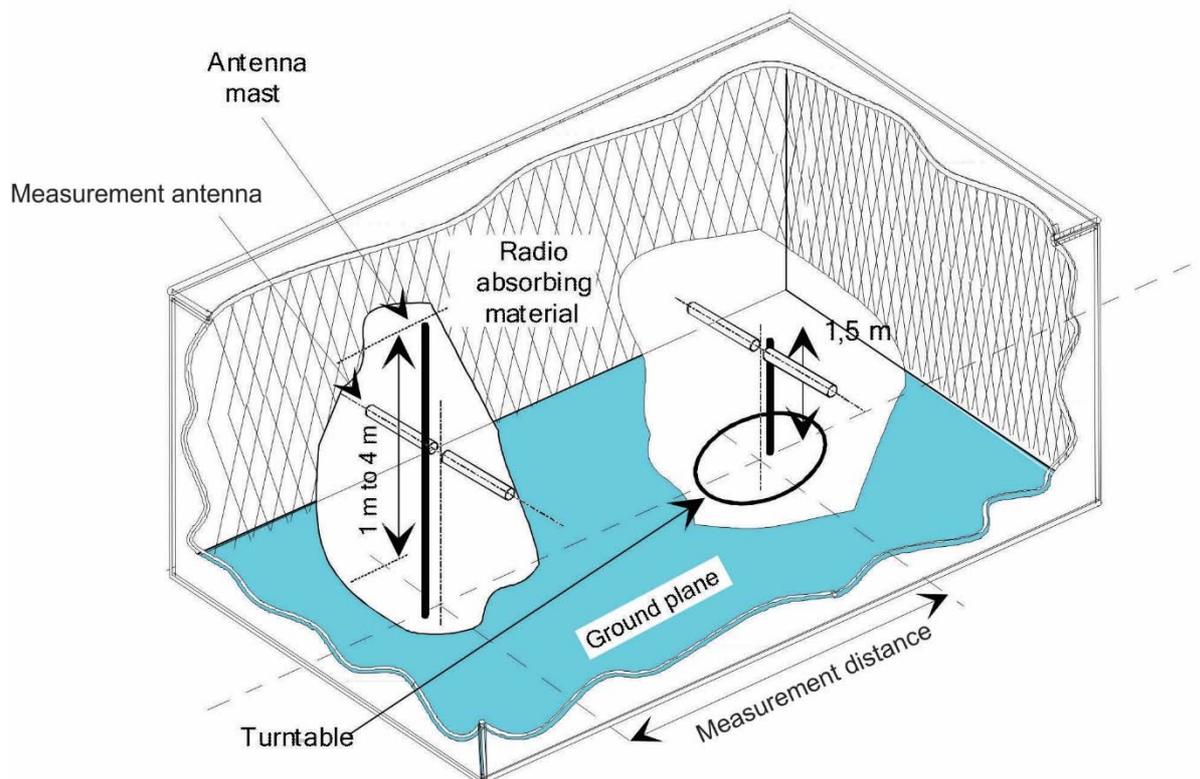


Figure D.2: A typical Semi Anechoic Room

In this facility the ground plane creates a wanted reflection path, such that the signal received by the receiving antenna is the sum of the signals received from the direct and reflected transmission paths. The phasing of these two signals creates a unique received level for each height of the transmitting antenna (or EUT) and the receiving antenna above the ground plane.

The antenna mast provides a variable height facility (from 1 m to 4 m) so that the position of the measurement antenna can be optimized for maximum coupled signal between antennas or between a EUT and the measurement antenna.

A turntable is capable of rotation through 360° in the horizontal plane and it is used to support the test sample (EUT) at a specified height, 1,5 m above the ground plane.

The measurement distance can be found in clause D.1.4. The distance used in actual measurements shall be recorded with the test results.

Further information on Semi Anechoic Rooms can be found in ETSI TR 102 273-3 [i.11].

D.1.3 Fully Anechoic Room (FAR)

A Fully Anechoic Room is an enclosure, usually shielded, whose internal walls, floor and ceiling are covered with radio absorbing material. The chamber usually contains an antenna support at one end and a turntable at the other end. A typical Fully Anechoic Room is shown in Figure D.3.

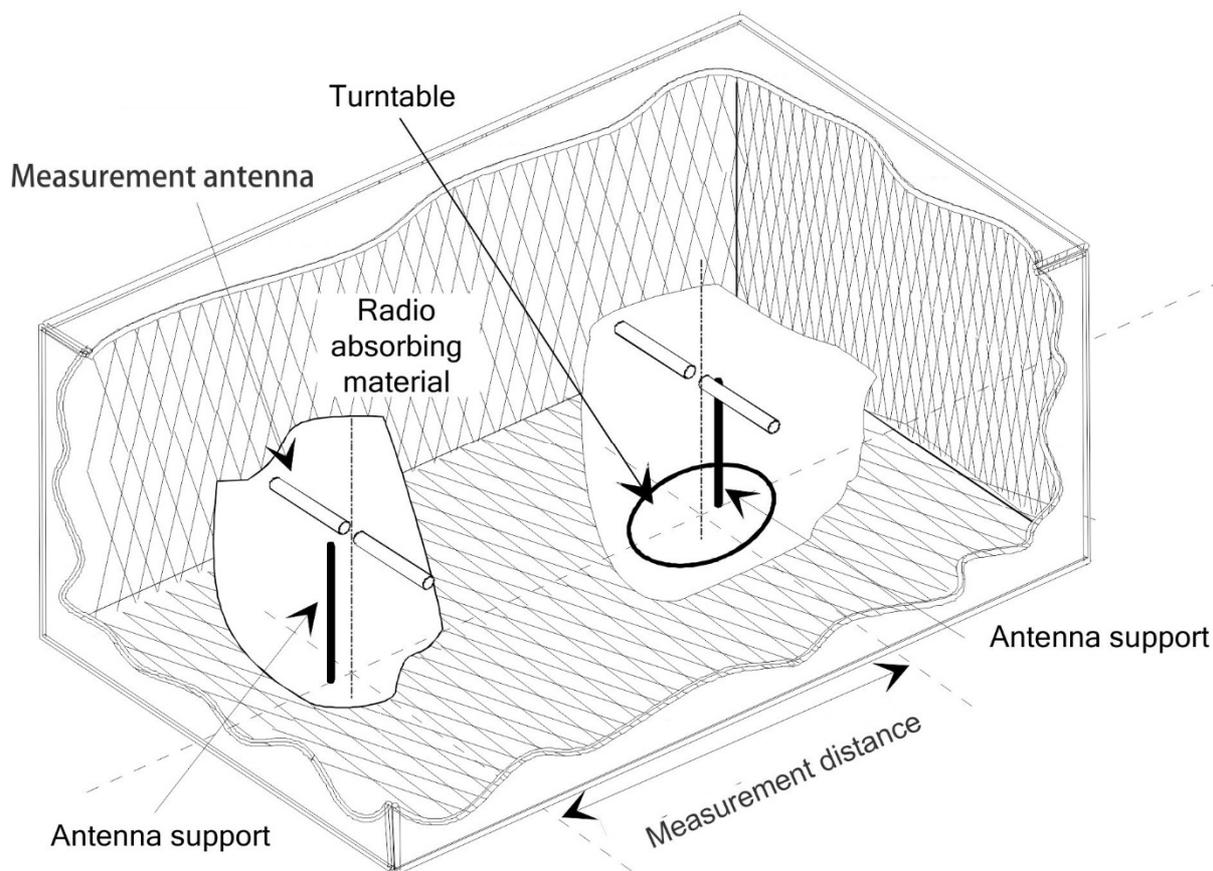


Figure D.3: A typical Fully Anechoic Room

The chamber shielding and radio absorbing material work together to provide a controlled environment for testing purposes. This type of test chamber attempts to simulate free space conditions.

The shielding provides a test space, with reduced levels of interference from ambient signals and other outside effects, whilst the radio absorbing material minimizes unwanted reflections from the walls and ceiling which can influence the measurements. The shielding should be sufficient to eliminate interference from the external environment that would mask any signals that have to be measured.

A turntable is capable of rotation through 360° in the horizontal plane and it is used to support the EUT at as close as possible to a height of 1,5 m above the ground plane.

Equipment which is intended to be worn on a person may be tested using a simulated man as support. The simulated man comprises a rotatable acrylic tube filled with salt water, placed on the ground.

The container shall have the following dimensions:

- Height: 1,7 ± 0,1 m;
- Inside diameter: 300 ± 5 mm;
- Sidewall thickness: 5 ± 0,5 mm.

The container shall be filled with a salt (NaCl) solution of 1,5 g per litre of distilled water.

The equipment shall be fixed to the surface of the simulated man, at the appropriate height for the equipment.

NOTE: To reduce the weight of the simulated man it may be possible to use an alternative tube which has a hollow centre of 220 mm maximum diameter.

The measurement distance can be found in clause D.1.4. The distance used in actual measurements shall be recorded with the test results.

Further information on Fully Anechoic Rooms can be found in ETSI TR 102 273-2 [i.10].

D.1.4 Measurement Distance

The measurement distance should be chosen in order to measure the EUT at far-field conditions. The minimum measurement distance between the equipment and the measurement antenna should be λ or $r_m \gg \frac{D^2}{\lambda}$, whichever is the greater.

λ = wavelength in m

r_m = minimum measurement distance between EUT and measurement antenna in m

D = largest dimension of physical aperture of the largest antenna in the measurement setup, in m

D^2/λ = distance between outer boundary of radiated near field (Fresnel region) and inner boundary of the radiated far-field (Fraunhofer region) in m, also known as Rayleigh distance

3 m or 10 m are recommended measurement distances, where these conditions cannot be fulfilled and where the measurement distance would result in measurements in the near field (e.g. while measuring spurious emissions), this should be noted in the test report and the additional measurement uncertainty should be incorporated into the results. The measurement distance may also be dependent on the EUT size (e.g. 3 m distance when an EUT is mounted on/in a car is not allowed because EUT is exceeding the quiet zone of the test site.)

D.2 Antennas

D.2.0 General

Antennas are needed for the radiated measurements on the three test sites described in clause D.1. Depending on its use, the antenna will be designated "measurement antenna" or "substitution antenna".

D.2.1 Measurement antenna

In emission tests the measurement antenna is used to detect the field from the EUT in one stage of the measurement, and from the substitution antenna in the other stage. When the test site is used for the measurement of receiver characteristics, the antenna is used as the transmitting equipment.

The measurement antenna should be mounted on a support capable of allowing the antenna to be used in either horizontal or vertical polarization. Additionally, on an OATS or SAR, the height of the centre of the antenna above the ground should be variable over the specified range 1 m to 4 m. In the frequency band 30 MHz to 1 000 MHz, biconical or logarithmic periodic dipole antennas (LPDA) are recommended. Above 1 GHz, horn antennas or logarithmic periodic dipole antennas are recommended.

For spurious emission testing, however, a combination of biconical antennas (commonly term "bicones") and log periodic dipole array antennas (commonly term "log periodics") could be used to cover the entire 30 MHz to 1 000 MHz band.

The measurement antenna needs an absolute calibration unless a substitution method is used.

D.2.2 Substitution antenna

The substitution antenna shall be used to replace the equipment under test in substitution measurements.

Shall be suitable for the frequency range and the return loss of the antenna shall be taken into account when calculating the measurement uncertainty.

The phase centre of this antenna shall coincide with the reference point of the test sample it has replaced. Therefore antennas with a phase centre that changes as a function of frequency are not suitable as a substitution antenna.

The reference point of the substitution antenna shall coincide with the volume centre of the EUT when its antenna is internal, or the point where an external antenna is connected to the EUT.

The distance between the lower extremity of the antenna and the ground shall be at least 30 cm.

The substitution antenna shall be calibrated. For below 1 GHz, the calibration is relative to a half wave dipole, while above 1 GHz, an isotropic radiator is the reference.

NOTE: Calibration figures intended for use above a reflective surface cannot be used in an anechoic chamber or vice versa.

D.3 Guidance on the use of radiation test sites

D.3.0 General

This clause details procedures, test equipment arrangements and verification that should be carried out before any of the radiated test are undertaken. These schemes are common to all types of test sites described in clause D.1.

Where necessary, a mounting bracket of minimal size should be available for mounting the EUT on the turntable. This

bracket should be made from low conductivity, low relative permittivity (i.e. $\frac{\epsilon}{\epsilon_0} < 1,5$) material(s) such as expanded polystyrene, balsawood, etc.

D.3.1 Power supplies for the battery powered EUT

All tests should be performed using power supplies wherever possible, including tests on EUT designed for battery-only use. For battery powered equipment, power leads should be connected to the EUT's supply terminals (and monitored with a digital voltmeter) but the battery should remain present, electrically isolated from the rest of the equipment, possibly by putting tape over its contacts.

The presence of these power cables can, however, affect the measured performance of the EUT. For this reason, they should be made to be "transparent" as far as the testing is concerned. This can be achieved by routing them away from the EUT and down to the either the screen, ground plane by the shortest possible paths. Power cables shall be equipped with ferrite immediately at EUT. Ferrite bead shall present an impedance of at least 100 Ω at 100 MHz.

D.3.2 Site preparation

The cables to the measuring and substitution antenna should be routed horizontally away from the testing area for a minimum of 2 m (unless, in the case both types of anechoic chamber, a back wall is reached) and then allowed to drop vertically and out through either the ground plane or screen (as practical) to the test equipment. Precautions should be taken to minimize pick up on these leads. The cables, their routing and dressing should be identical to the verification set-up.

NOTE: For ground reflection test sites (i.e. anechoic chambers with ground planes and Open Area Test Sites) which incorporate a cable drum with the antenna mast, the 2 m requirement may be impossible to comply with.

Calibration data for all items of test equipment should be available and valid. For test, substitution and measuring antennas, the data should include gain relative to an isotropic radiator (or antenna factor) for the frequency of test. Also, the VSWR of the substitution and measuring antennas should be known.

The calibration data on all cables and attenuators should include insertion loss and VSWR throughout the entire frequency range of the tests. All VSWR and insertion loss figures should be recorded in the log book results sheet for the specific test.

Where correction factors/tables are required, these should be immediately available.

D.4 Coupling of signals

D.4.1 General

The presence of leads in the radiated field may cause a disturbance of that field and lead to additional measurement uncertainty. These disturbances can be minimized by using suitable coupling methods, offering signal isolation and minimum field disturbance (e.g. optical coupling).

D.4.2 Data Signals

Isolation can be provided by the use of optical, ultrasonic or infra-red means. Field disturbance can be minimized by using a suitable fibre optic connection. ultrasonic or infra-red radiated connections require suitable measures for the minimization of ambient noise.

D.5 Measurement procedures for radiated measurement

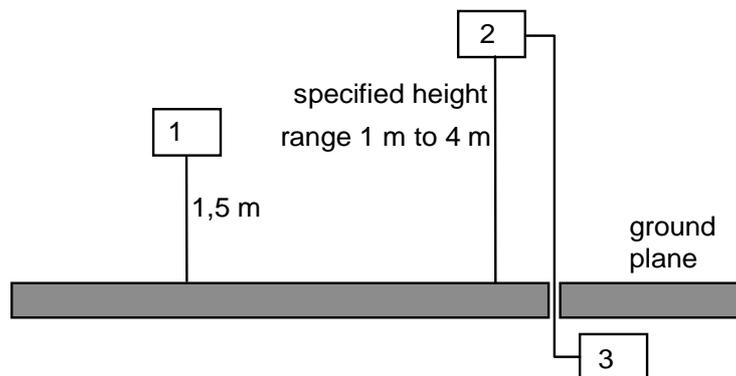
D.5.0 General

This clause gives the general procedures for radiated measurements using the test sites and arrangements described in annex D.

D.5.1 Radiated measurements in an OATS or SAR

Radiated measurements shall be performed with the aid of a measurement antenna and a substitution antenna described in clause D.2, in test sites described in clause D.1. The EUT and the measurement antenna shall be oriented such as to obtain the maximum emitted power level. This position shall be recorded in the measurement report:

- a) The measurement antenna (equipment 2 in Figure D.4) shall be oriented initially for vertical polarization unless otherwise stated and the EUT (equipment 1 in Figure D.4) shall be placed on the support in its standard position and switched on.
- b) The measurement equipment (equipment 3 in Figure D.4) shall be connected to the measurement antenna and set-up according to the specifications of the test.



- 1) EUT
- 2) Measurement antenna
- 3) Measurement equipment

Figure D.4: Measurement arrangement No.1

- c) The EUT shall be rotated through 360° in a horizontal plane until a maximum signal is received at the measurement equipment.

- d) The measurement antenna shall be raised or lowered again through the specified height range until a maximum is obtained at the measurement equipment. This level shall be recorded.
- e) This measurement shall be repeated for horizontal polarization.

NOTE: This maximum may be a lower value than the value obtainable at heights outside the specified limits.

D.5.2 Radiated measurements in a FAR

For radiated measurements using a FAR, the procedure is identical to the one described in clause D.5.1, except that the height scan is omitted.

D.5.3 Substitution measurement

To determine the absolute measurement value a substitution measurement is performed. The following steps shall be performed:

- 1) Replacing the EUT with the substitution antenna that is depicted as equipment 1 in Figure D.4. The substitution antenna will have vertical polarization.
- 2) Connect a calibrated signal generator to the substitution antenna, and adjust it to the measurement frequency.
- 3) If an OATS or a SAR is used, the measurement antenna shall perform a height scan from 1m to 4m, to ensure that the maximum signal is received at the measurement equipment.
- 4) Subsequently, the power of the signal generator shall be adjusted until the same level is obtained again at the measurement equipment as with the EUT.
- 5) The radiated power is equal to the power supplied by the signal generator, increased by the substitution antenna gain minus the cable losses (The values of cable losses and antenna gain are expressed in dB).
- 6) This measurement shall be repeated with horizontal polarization.

NOTE: For test sites with a fixed setup of the measurement antenna(es) and a reproducible positioning of the EUT, correction values from a verified site calibration can be used alternatively.

D.5.4 Radiated measurement for receivers

Measurements on receiving equipment are essentially the reverse of measurements on transmitters, with a signal generator connected to the measuring antenna. Calibration relies on the principle of replacing the EUT with a substitution antenna and suitable measuring equipment.

Clause D.2.2 Substitution antenna applies.

NOTE: This does not require an actual half wave dipole, only an antenna with known gain relative to a half wave dipole.

There are two methods:

- a) Connect the substitution antenna to a calibrated measuring receiver and read the measurement result directly.
- b) Measure the path loss from the measurement antenna to the substitution antenna and subtract this from the signal generator level to reach the measurement result.

For method a) the level received in some measurements is likely to be too low, so it may be necessary to raise the signal generator by a suitable amount and apply an equivalent offset to the measurement result.

Method b) means that one calibration measurement can be used for multiple tests.

D.6 Guidance for testing technical requirements

D.6.0 General

This clause provides guidance on how the various technical requirements can be verified using radiated measurements.

D.6.1 Radio test suites and corresponding test sites

Table D.1 provides guidance on the test site to be used for each of the radio tests when performing radiated measurements on equipment with integral antenna.

Table D.1: Radio conformance tests and corresponding test sites

Radio conformance test - Clause number	Small size EUT (note1) corresponding test site - Clause number(s)	Medium size EUT (note 2) corresponding test site - Clause number(s)	Large size EUT (note 3) corresponding test site - Clause number(s)
5.3	D.1.3 (FAR)	D.1.2 (SAR)	D.1.1 (OATS)
5.4	D.1.3 (FAR)	D.1.2 (SAR)	D.1.1 (OATS)
5.5	D.1.3 (FAR)	D.1.2 (SAR)	D.1.1 (OATS)
5.6	D.1.3 (FAR)	D.1.2 (SAR)	D.1.1 (OATS)
Additional condition	If D1.3 test site (FAR) is not available, D1.2 (SAR) shall be used instead, but measurements may be influenced by the ground plane reflections. A specific calibration of path loss is required.	If D1.2 test site (SAR) is not available, D1.1 (OATS) shall be used instead, but measurements may be influenced by the ground plane reflections. A specific calibration of path loss is required.	
NOTE 1: Small size EUT is an EUT with the maximum dimension excluding leads <1,5 m.			
NOTE 2: Medium size EUT is an EUT with the maximum dimension excluding leads between $\geq 1,5$ m and 2,5 m.			
NOTE 3: Large size EUT is an EUT with the maximum dimension excluding leads is $\geq 2,5$ m.			

Annex E (normative): Test fixture

E.1 General considerations

With equipment intended for use with an integral antenna, and not equipped with a 50 Ω RF output connector, a test fixture as shown in Figure E.1 may be used for relative measurements.

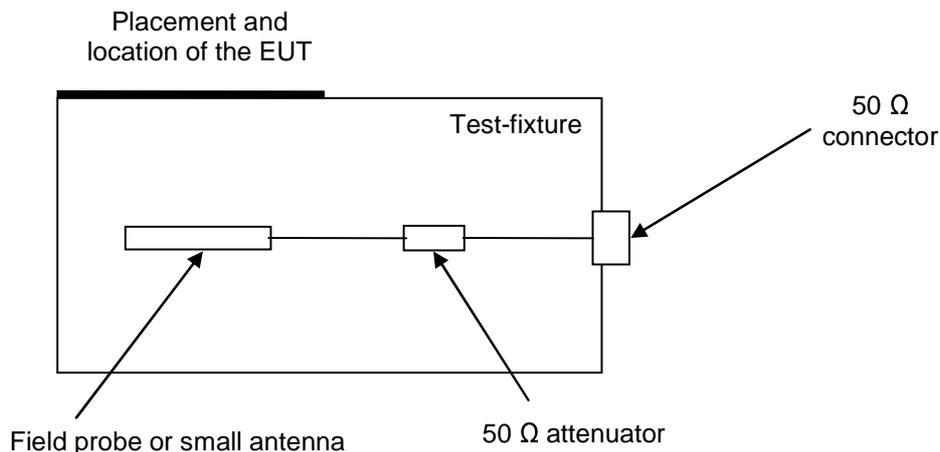


Figure E.1: Test fixture

Where a test fixture as defined in the present clause is used for measurements on integral antenna equipment, tests on radiated signals under normal test condition shall be carried out without the test fixture. Level measured will be used as reference levels.

This fixture is a radio frequency device for coupling the integral antenna to a 50 Ω RF terminal at all frequencies for which measurements need to be performed under extreme temperature condition.

In addition, the test fixture may provide:

- a) a connection to an external power supply;
- b) a method to provide the input to or output from the equipment.

NOTE: This may include coupling to or from the antenna. The test fixture could also provide suitable coupling means e.g. for data or video outputs.

The performance characteristics of the test fixture shall conform to the following basic parameters:

- a) the coupling loss shall not be greater than 30 dB;
- b) the coupling loss variation over the frequency range used in the measurement shall not exceed 2 dB under all test conditions;
- c) circuitry associated with the RF coupling shall contain no active or non-linear devices;
- d) the VSWR at the 50 Ω socket shall not be more than 1,5 over the frequency range of the measurements;
- e) the coupling loss shall be independent of the position of the test fixture and be unaffected by the proximity of surrounding objects or people. The coupling loss shall be reproducible when the equipment under test is removed and replaced. Normally, the test fixture is in a fixed position and provides a location for the EUT;

The attenuation of the test fixture coupling should be such that the received signal at the measuring instrument is at least 10 dB above the measuring instrument noise floor. If the attenuation is too great it can be compensated by linear amplification outside the test-fixture.

The characteristics and validation of the test fixture shall be documented in the test report.

E.2 Validation of the test-fixture in the temperature chamber

The following is an example test fixture validation procedure to be followed if test fixture measurements are performed under extreme temperature conditions. Other validation procedures may be used.

A description of the validation procedure used shall be included in the test report.

The test fixture is brought into a temperature chamber.

Step 1:

As shown in Figure E.2, a transmit antenna connected to a signal generator shall be positioned from the test-fixture at a far field distance of not less than one λ at the frequency. The test fixture consists of the mechanical support for the EUT, an antenna or field probe and a $50\ \Omega$ attenuator for proper termination of the field probe. The test fixture shall be connected to a spectrum analyser via the $50\ \Omega$ connector.

The signal generator shall be set to operate on the nominal frequency of the EUT. The unmodulated output power of the signal generator shall be set to a value such that a sufficiently high level can be observed with the spectrum analyser. This value shall be recorded in the test report. The signal generator shall then be set to the upper and the lower band limit of the 'UT's Permitted Frequency Band. The measured values shall not deviate more than 1 dB from the value at the nominal frequency. The distance between test antenna and test fixture may be reduced to $\lambda/2$ for frequencies below 100 MHz.

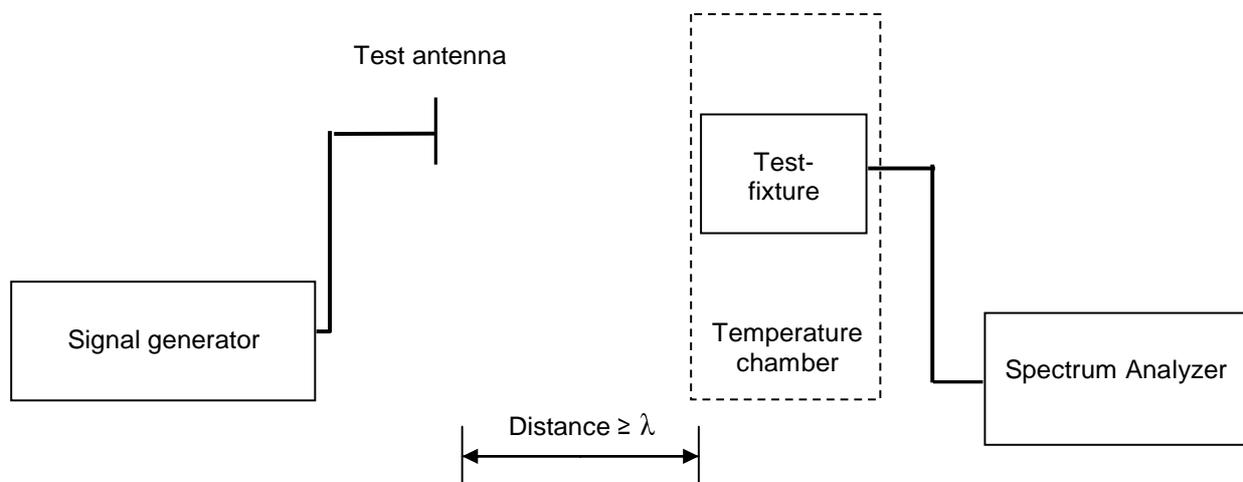


Figure E.2: Validation of test set-up without EUT

Step 2:

During validation and testing the EUT shall be fitted to the test fixture in a switched-off mode as shown in Figure E.3. Step 1 shall be repeated, this time with the EUT in place. The measured values shall be compared with those from step 1 and may not vary by more than 2 dB. This shows that the EUT does not cause any significant shadowing of the radiated power.

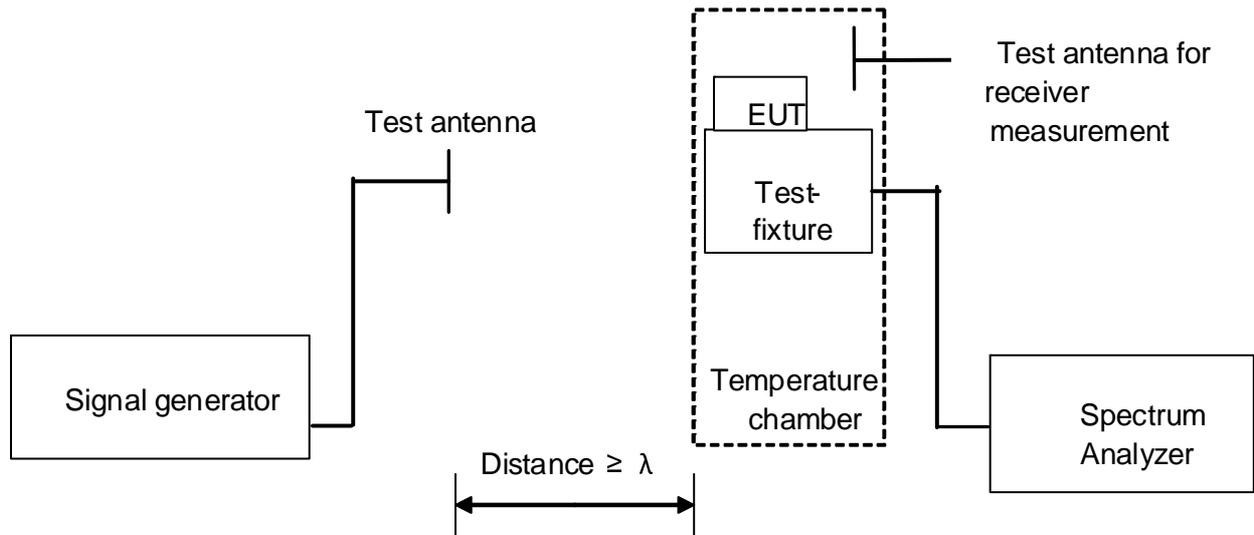


Figure E.3: Validation of test set-up with EUT in place

Step 3:

In the case of a battery operated EUT that is supplied by a temporary voltage feed, a decoupling filter shall be installed directly at the EUT in order to avoid parasitic electromagnetic radiation. See Figure E.4.

In this step the signal generator and the transmit antenna are removed.

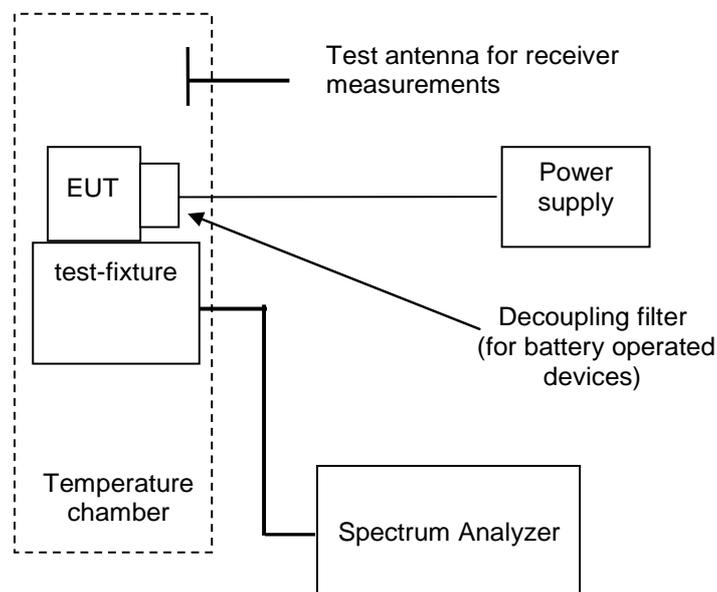


Figure E.4: Test of EUT

E.3 Mode of use

The test fixture may be used to facilitate some of the transmitter and receiver measurements in the case of equipment having an integral antenna. See clause 5.2.8 for guidance on applicable use of the test fixture in conformance methods of measurement for the present document.

To measure a power under extreme temperature conditions with a test fixture, the following steps apply:

Step 1:

EUT tests on radiated signals under normal test condition shall be carried out without the test fixture . Level measured will be used as reference level R.

Step 2:

Test is now performed with the test fixture in place in the temperature chamber under normal temperature condition. Level measured is level A.

Step 3:

At the frequency for which a measurement needs to be performed under extreme temperature condition, the level B is measured according clause 5.2.4.

At all frequencies for which measurements need to be performed under extreme temperature condition, the radiated power level under extreme temperature is calculated with the following formula:

$$\text{Radiated Power (under extreme temperature condition)} = \frac{R \times B}{A}$$

Annex F (informative): Guideline for Operating Channel

F.1 Operating channel calculation

This annex intends to help the reader to understand how the concept of operating channel, which was introduced many years ago, is used in order to have a similar testing approach for equipment using channelized spectrum (clause 4.2.4 Bands D and J) and for equipment using non channelized spectrum (i.e. the majority of SRDs).

Nominal operating frequency and Operating Channel are EUT properties given by the intended use of the EUT. Nevertheless, operating channels have to comply with operating conditions described in clause 4.2.3. These conditions are illustrated below.

Maximum Operating Channel Width value is a result of a calculation depending on the frequency offset between F_{nom} and the permitted frequency band edges which is provided in Table F.1.

Table F.1: Single nominal operating frequency EUT

F_{nom}	Max value for OCW	Operating Channel edges
Any value between FB_{low} and FB_{high}	$2 * \min((F_{nom} - FB_{low}), (FB_{high} - F_{nom}))$	$FOC_{low} = F_{nom} - \frac{OCW}{2}$ $FOC_{high} = F_{nom} + \frac{OCW}{2}$

Calculation for EUT with multiple (n) nominal operating frequencies is provided in Table F.2.

Table F.2: Multiple nominal operating frequency EUT

F_{nom}	Max value for OCW_n	Operating Channel edges
Any value between FB_{low} and FB_{high}	$2 * \min((F_{nom_n} - FB_{low}), (FB_{high} - F_{nom_n}))$	$FOC_{low_n} = F_{nom_n} - \frac{OCW_n}{2}$ $FOC_{high_n} = F_{nom_n} + \frac{OCW_n}{2}$

F.2 Operating channel illustrations

Various examples to avoid misinterpretation by manufacturers and test laboratories are provided below.

Figure F.1 is an example of a single nominal operating frequency EUT, where the OCW is limited by the close proximity of the lower edge of the permitted frequency band.

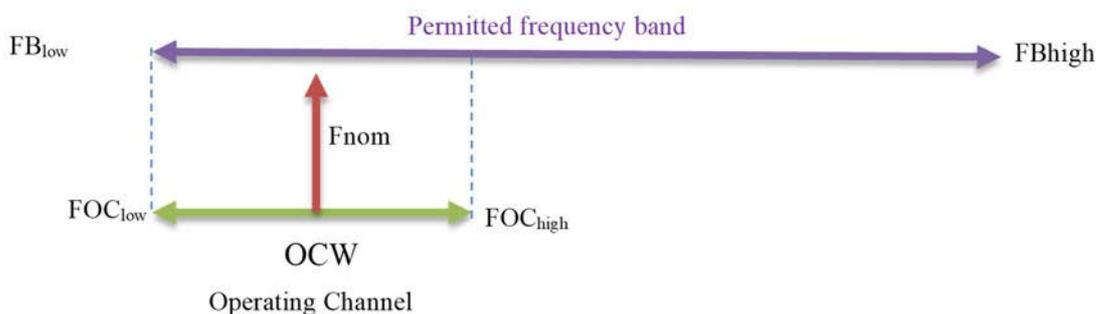


Figure F.1: Illustration of single nominal operating frequency EUT

Figure F.2 is an example of a single nominal operating frequency EUT, where the OCW is set by the intended use of the equipment.

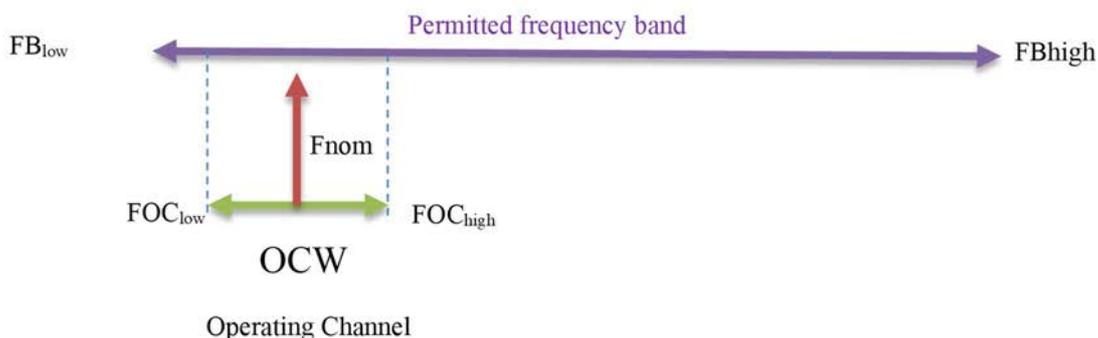


Figure F.2: Illustration of single nominal operating frequency EUT

Figure F.3 illustrates a single frequency EUT with an operating channel which does not comply with operating conditions set in clause 4.2.3 of this Harmonised Standard, since the F_{nom} is not centred in the Operating Channel.

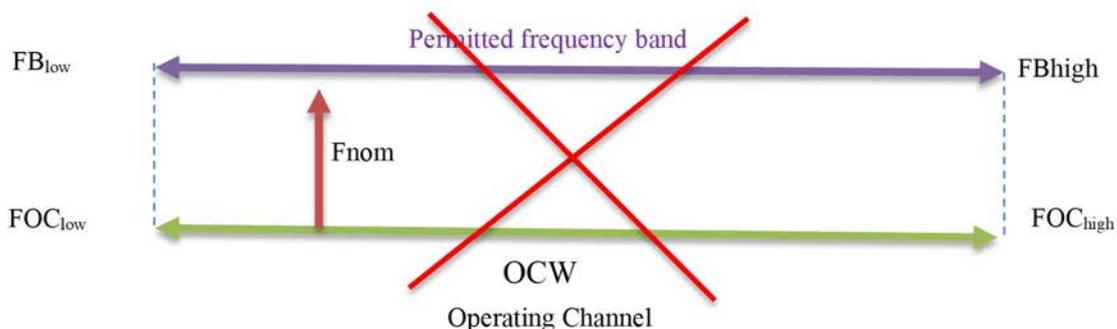


Figure F.3: Illustration of an incorrect OC for single frequency EUT and single nominal operating frequency EUT

An example of EUT with single nominal operating frequency but multiple sub-carriers is shown in Figure F.8.

Figure F.4 illustrates an EUT with two operating channels, where OCW1 (resp. OCW2) is limited by the close proximity of the lower (resp. higher) edge of the permitted frequency band.

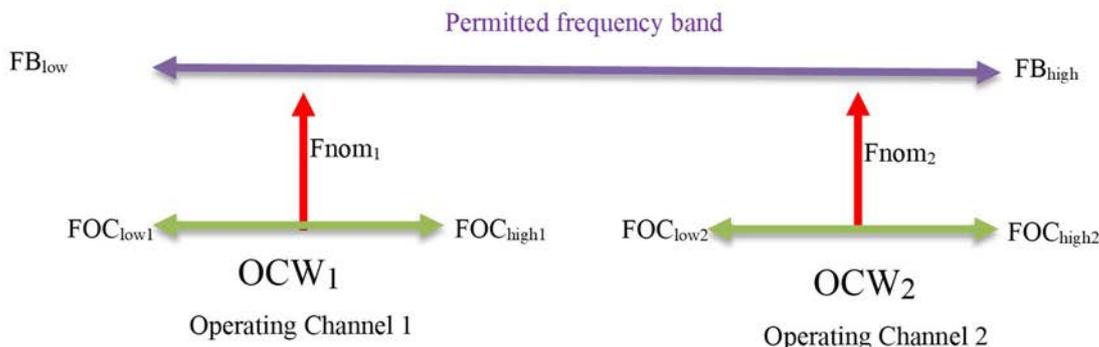


Figure F.4: Illustration of dual nominal operating frequency EUT

Figure F.5 illustrates an FHSS or AFA EUT with two operating channels, where their OCW are limited by the non-overlapping requirement of operating channels (i.e. contiguous channels).

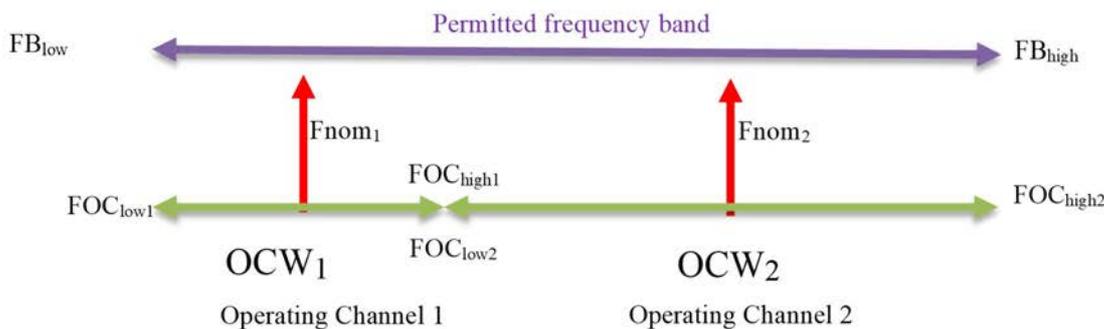


Figure F.5: Illustration of dual nominal operating frequency EUT

Figure F.6 illustrates an EUT transmitting the same type of signal within the same OCW value, but in different permitted frequency bands.

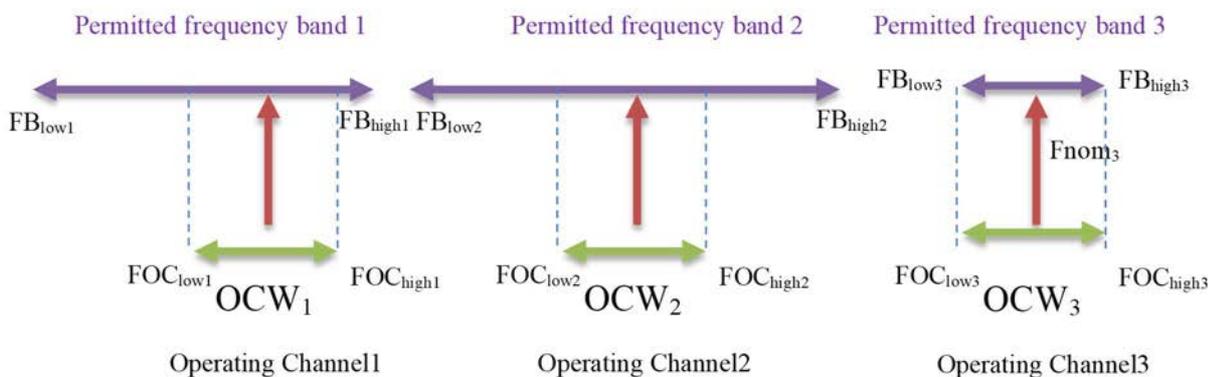


Figure F.6: Illustration EUT using multiple permitted frequency bands

For EUTs operating over multiple nominal operating frequencies in a permitted frequency band where channel spacing is not defined by regulation, not using FHSS or AFA, channels may overlap. An example is shown in Figure F.7.

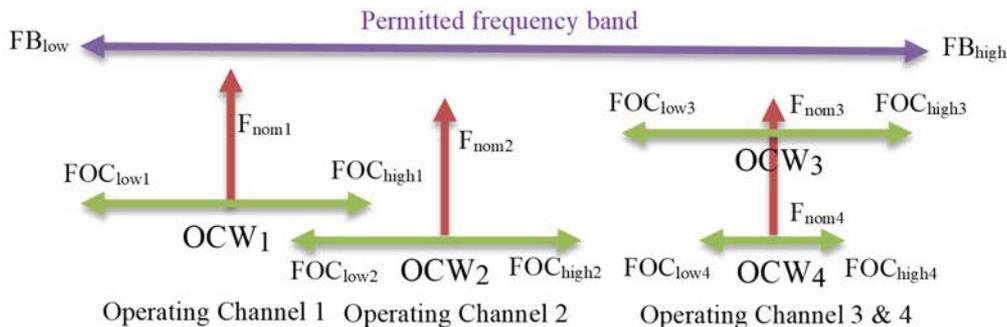


Figure F.7: Illustration of multiple nominal operating frequency EUT with overlapping channels

EUT transmission using a modulation with sub-carriers in an operating channel is illustrated in Figure F.8.

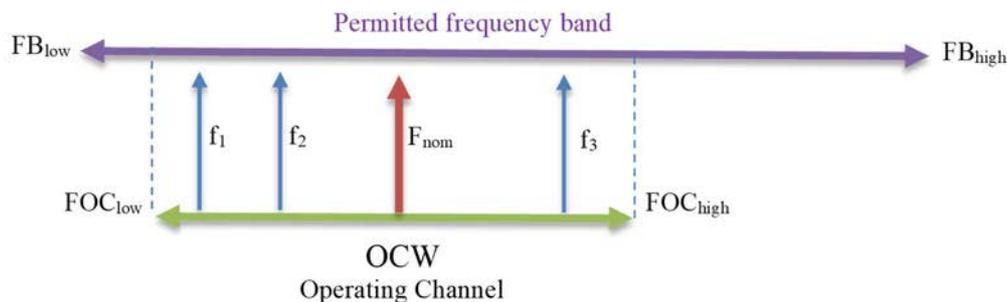


Figure F.8: Illustration of EUT using sub-carrier modulation in an operating channel

Annex G (informative): Properties of EUT

G.1 Rights to copy

Notwithstanding the provisions of the copyright clause related to the text of the present document, ETSI grants that users of the present document may freely reproduce the form in this annex so that it can be used for its intended purposes and may further publish the completed form.

G.2 EUT properties

This annex lists the EUT properties knowledge of which is necessary for the execution of the conformance test suites in the present document. This form should form an integral part of the test report.

Property	Value	Units
Permitted Frequency Band(s)		MHz
Nominal operating frequency (ies)		MHz
Highest nominal operating frequency for AFA or FHSS equipment		MHz
Lowest nominal operating frequency for AFA or FHSS equipment		MHz
Operating channel(s), FOC _{low} and FOC _{high} of each OC		MHz
Local oscillator frequency (f_{LO})		MHz
Intermediate frequency (f_{IF})		MHz
Intermediate frequency (f_{IF1}) and (f_{IF2}) in case of second IF filter		
External antenna gain relative to dipole		
For equipment with non-integral antenna		dBd
Technical description of D-M2, D-M3 (Information necessary to be able to synthesize test signals representative of intended use)		
Unmodulated carrier, if the equipment is able to generate test signal D-M1 or not	<input type="checkbox"/> Yes <input type="checkbox"/> No	
Disregard time ($T_{Disregard}$)		μ s
Upper and lower temperatures of the environmental profile given by the intended use		$^{\circ}$ C
Nominal mains voltage (or range of voltages)		Vac
Nominal battery voltage		V
Upper and lower voltage range from environmental profile given by the intended use		V
Spectrum access mechanism: LBT+AFA (polite spectrum access) or Duty Cycle	<input type="checkbox"/> LBT+AFA <input type="checkbox"/> Duty Cycle	
For EUT with polite spectrum access: CCA time		ms
For EUT using FHSS technique		
Hopping channel bandwidth		kHz
List of all hopping channels, FOC _{low} and FOC _{high} of each Operating Channel		kHz
Dwell time		ms
CCA feature	<input type="checkbox"/> Yes <input type="checkbox"/> No	

Annex H (informative): Maximum measurement uncertainty

The measurements described in the present document are based on the following assumptions:

- the measured value related to the corresponding limit is used to decide whether an equipment meets the requirements of the present document;
- the value of the measurement uncertainty for the measurement of each parameter is included in the test report.

Table G.1 shows the recommended values for the maximum measurement uncertainty figures.

Table G.1: Maximum measurement uncertainty

Parameter	Uncertainty
Radio frequency	$\pm 0,5\text{ppm}$
Radio frequency derived from OBW measurement	$\pm(0,5\text{ppm} + 2\% \text{ of OBW})$
RF power, conducted	$\pm 1,5 \text{ dB}$
Conducted spurious emission of transmitter, valid up to 6 GHz	$\pm 3 \text{ dB}$
Conducted emission of receivers	$\pm 3 \text{ dB}$
Radiated emission of transmitter, valid up to 6 GHz	$\pm 6 \text{ dB}$
Radiated emission of receiver, valid up to 6 GHz	$\pm 6 \text{ dB}$
RF level uncertainty for a given BER	$\pm 1,5 \text{ dB}$
Temperature	$\pm 1 \text{ }^\circ\text{C}$
Humidity	$\pm 10 \%$
Time	$\pm 5 \%$

Annex I (informative): Selection of technical parameters

ETSI EG 203 336 [i.4], clause 5 lists the technical parameters applicable to transmitters and receivers that should be considered when producing Harmonised Standards that are intended to cover the essential requirements in article 3.2 of Directive 2014/53/EU [i.2]. Essential requirements are high level objectives described in European Directives. The purpose of the Harmonised Standard is to translate those high level objectives into detailed technical specifications. Table I.1 contains the parameters listed in ETSI EG 203 336 [i.4], clause 5 for transmitter and receiver, and cross references these to the clauses within the present document in which the requirements for measurement of such parameters are satisfied or justified.

Table I.1: Cross reference of clauses in the present document to technical parameters for transmitter and receiver listed in ETSI EG 203 336

ETSI EG 203 336 [i.4]		Present document		Justification
Clause	Parameter	Clause	Parameter	
5.2.2	Transmitter power limits	4.4.1 4.4.2	Effective radiated power Maximum e.r.p. power spectral density	
5.2.3	Transmitter power accuracy	-	-	From the latest version of ETSI EG 303 336 [i.4] "When regulatory limits imply only a maximum emission limit (e.g. products that operate under a general licence regime), this parameter need not be considered for inclusion in an HS."
5.2.4	Transmitter spectrum mask	4.4.4 4.4.7 4.4.8	Maximum occupied bandwidth Adjacent channel power Transmitter spectrum mask at band edges	
5.2.5	Transmitter frequency stability	4.4.5	Transmitter frequency stability	
5.2.6	Transmitter intermodulation attenuation	-	-	From latest version of ETSI EG 303 336 [i.4] this parameters is required only "where high levels of quality services are required". This is not relevant for generic short range devices which are operating under licence except regime without any kind of regulatory protection. SRDs have to accept interferences. Equipment in the scope are also limited to low power not exceeding 500 mW.
5.2.7.2	Transmitter unwanted emissions in the out of band domain	4.4.6	Transmitter out of band emissions	
5.2.7.3	Transmitter unwanted emissions in the spurious domain	4.3.1	Unwanted emissions in the spurious domain	
5.2.8	Transmitter time domain characteristics	4.4.3 4.6.2	Duty cycle Polite spectrum access timing parameters	
5.2.9	Transmitter transients	4.4.9	Transient power	
5.3.2	Receiver sensitivity	4.5.1	Receiver sensitivity	A high sensitivity level is required for SRDs using polite spectrum access in order to detect properly the presence of energy in an operating channel. The sensitivity level for limit for duty cycle based equipment is calculated as the maximum allowed e.r.p. minus the minimum dynamic range limit requirement in clause 4.5.2.

ETSI EG 203 336 [i.4]		Present document		Justification
Clause	Parameter	Clause	Parameter	
5.3.2.3	Desensitization	-	-	From latest version of ETSI EG 303 336 [i.4] "As desensitization is a receiver effect addressed by other parameters, its inclusion as a separate parameter in an HS is not required."
5.3.3	Receiver co-channel rejection	-	-	Receiver co-channel rejection (ETSI EG 303 336 [i.4], clause 5.3.3) is a measure of the capability of a receiver to receive a wanted signal, without exceeding a given degradation, due to the presence of an unwanted signal, both signals being at the nominal frequency of the receiver. Co Channel rejection performance will be dependent on the minimum signal to noise ratio that is required for demodulation of a certain modulation. It is considered that this parameter is more related to the modulation chosen by the manufacturer than the RF silicon used in the equipment. On silicones designed for Short Range Devices, it is recognized that co-channel rejection is easier to pass with old fashion modulation such as 2 FSK rather than with complex up to date digital modulations which are by themselves much more spectrum efficient in term of bit/s/Hz. This will hamper more spectral efficient modulation types like 4 GFSK vs 2 GFSK or 16 QAM vs. GFSK. More spectral efficient modulation formats have the huge benefit of reducing the over the air time ensuring a better spectrum sharing. To reduce the transmission time is the best coexistence scenario to promote for Short Range Devices, which cannot claim for any kind of regulatory protection. For example, where 100 bits are transmitted at a rate of 10 kb/s in a 1 MHz operating channel with a 2 FSK, it represents 10 ms of transmission, With an OFDM at 1 Mb/s it represents only 0,1 ms of transmission occupancy. The over the air time can be reduced by 100, even more on wider operating channels. It is important to note that new complex type of modulation such as OFDM are already on the market and strongly pushed by applications widely deployed such as metering. Applying this receiver parameter with a value fitting all modulations does not result in an efficient use of the spectrum for SRDs. Moreover, in frequency bands covered by the present document, any modulation, channel width, operating frequency and data rate may be used. A combination of many signals of widely different characteristics manifests itself primarily as an increase in the noise floor. Consequently, the present document relies on a combination of sensitivity requirement (clause 4.5.1), blocking requirement (clause 4.5.4) and the knowledge of the manufacturer to ensure receivers are adequately resilient against interference in the operating channel
5.3.4.2.1	Receiver adjacent channel selectivity	4.5.3	Adjacent channel selectivity	Adjacent channel selectivity is also covering desensitization. Adjacent channel selectivity is specified in clause 4.5.3 for receivers using channelized spectrum as it was previously only applicable to Rx category 1 in life critical applications with a bandwidth of 25 kHz. For other receivers, not using channelized spectrum, the adjacent channel is not defined and there is no specific frequency relationship with equipment transmitting in adjacent permitted frequency bands. For other receivers, the present document relies on blocking requirement (clause 4.5.4) to ensure receiver resilience with adjacent radio services.

ETSI EG 203 336 [i.4]		Present document		Justification
Clause	Parameter	Clause	Parameter	
5.3.4.2.2	Receiver adjacent band selectivity	4.5.4	Blocking	Blocking is also covering desensitization.
5.3.4.3	Receiver blocking	4.5.4	Blocking	Blocking is also covering desensitization.
5.3.4.4	Receiver spurious response rejection	4.5.5	Receiver spurious response rejection	
5.3.4.5	Receiver radio-frequency intermodulation	4.5.6	Receiver intermodulation response rejection	Intermodulation rejection selectivity is specified in clause 4.5.6 for receivers using channelized spectrum as it was previously only applicable to Rx category 1 in life critical applications with a bandwidth of 25 kHz. For other receivers, not using channelized spectrum, the adjacent channel is not defined and there is no specific frequency relationship with equipment transmitting in adjacent permitted frequency bands therefore intermodulation rejection is not representing any real use case. Intermodulation effects will manifest themselves as blocking effects and the present document relies on blocking requirement (clause 4.5.4) to ensure receiver resilience in the shared spectrum environment.
5.3.5	Receiver unwanted emissions in the spurious domain	4.3.1	Unwanted emissions in the spurious domain	
5.3.6.1	Receiver dynamic range	4.5.2	Receiver dynamic range	
5.3.6.2	Reciprocal mixing	4.5.3 4.5.4	Adjacent channel selectivity Blocking	It is considered that reciprocal mixing effects (ETSI EG 303 336 [i.4], clause 5.3.6.2) manifest themselves as blocking effects and the present document relies on limits and test suites for blocking requirement (clause 4.5.4) and adjacent channel selectivity requirement (clause 4.5.3) to ensure receiver resilience in the shared spectrum environment. Reciprocal mixing is an effect within a receiver that limits performance rather than a parameter that can be measured on a complete SRD receiver.
5.3.1	Signal interferer handling	-	-	Signal interferer handling (ETSI EG 303 336 [i.4], clause 5.3.1) is an alternative method for specifying receiver parameters intended for use for receivers such as UWB and certain types of radar equipment. The present document is intended for communications equipment and specifies receiver requirements and measurement methods for all receiver parameters listed above instead of signal interferer handling.

Annex J (informative): Bibliography

- Ketterling, H-P: "Verification of the performance of fully and semi-anechoic chambers for radiation measurements and susceptibility/immunity testing", 1991, Leatherhead/Surrey.
- ETSI TR 102 313 (V1.1.1): "Electromagnetic compatibility and Radio Spectrum Matters (ERM); Frequency-agile Generic Short Range Devices using listen-Before-Transmit (LBT); Technical Report".
- European Communication Office Frequency Information System.

NOTE: Available at <https://efis.cept.org/>

Annex K (informative): Change history

Version	Information about changes
3.1.1	First published version covering Directive 2014/53/EU [i.2]. Major change is: <ul style="list-style-type: none"> • New multi-part structure of ETSI EN 300 220 which is described in ETSI EN 300 220-1, clause "Foreword".
3.2.1	Published version covering Directive 2014/53/EU [i.2] with removal of receiver category 3. Minimum receiver category for compliance to Directive 2014/53/EU article 3.2 is set to category 2.
3.3.1	Major changes are: <ul style="list-style-type: none"> • Separation of OBW requirement from frequency stability (drift) clauses. • Clarifications in Spectrum mask at permitted frequency band edges. • Addition of receiver parameters according to ETSI guide ETSI EG 203336 (V1.2.1). • Addition of tests for timing compliance of equipment using polite spectrum access.

History

Document history		
Edition 1	October 1993	Publication as ETSI I-ETS 300 220
V1.2.1	November 1997	Publication
V1.3.1	September 2000	Publication
V2.1.1	April 2006	Publication
V2.1.2	June 2007	Publication
V2.3.1	February 2010	Publication
V2.4.1	May 2012	Publication
V3.1.1	February 2017	Publication
V3.2.1	June 2018	Publication
V3.2.2	March 2024	SRdAP EV 20240604: 2024-03-06 to 2024-06-04